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THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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THE GAS INTEREST AT THE CENTENNIAL.

CENTENNIAL COMMISSION.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
4 EAST TWENTY-THIRD STREET,
NEW YORK, February 2d, 1876.

SIR: It is of much importance to the gas interests of this country, that a representation of the progress of gas-lighting in America during the past century, should be made at the Centennial.

American engineers, superintendents and contractors of gas-works, desiring to contribute plans, models or drawings of gas-works or gas machinery, are respectfully notified that their contributions will be received and taken charge of by the committee of the American Society of Civil Engineers, and placed in the portion of the Centennial Buildings set apart for that purpose.

If you have plans, drawings or models you wish to contribute, please notify the undersigned at the earliest possible moment, and oblige,

Respectfully,
JAMES H. ARMINGTON,
Chairman Sub-Committee XIV,
City Gas Co., Brooklyn, N. Y.

—Or at Rooms of the Society.

THE MEETING OF THE NEW ENGLAND SOCIETY OF GAS ENGINEERS.

The annual meeting of this society was held at the Tremont House, Boston, week before last. Over a hundred members of the society were present and among them some of the best men in the business. After a very pleasant and, we are confident, a useful business meeting during the day the society dined together on the evening of Wednesday and on the following day met at the works of the Boston Gas Light Company by invitation of Mr. W. W. Greenough, its manager, who received the members in a most cordial manner. In a short address of welcome from Mr. Malcom S. Greenough, the society was invited to inspect the works, and each and every one was asked to avail himself most freely of anything they might see that was deemed worthy of adoption, and if at any time they might wish information as to experiments that had been made or the practical workings of the company they were assured that it would give the officers of the company the greatest pleasure to give it.

The best of feeling prevailed throughout all the proceedings, and we doubt not that every one returned to his daily routine of business feeling benefited by the meeting. As no reporters were present the interchange of views was free and practical, and although we shall not be able to give our readers a *verbatim* report of all that was said, we hope to lay before them such a synopsis of the proceedings as will give to those not present the general tenor of the discussion. From what we hear we do not believe that the majority of those present have as yet been fully convinced of the utility of substituting naphtha for coal in the manufacture of illuminating gas. The real benefit to be derived from meetings like this is after all outside of the regular society meetings. It is in the bringing together of numbers of men engaged in the same great interest—some to a larger and some to a smaller extent, and the talking over of matters of common interest; the little conferences that take place when five or six get together in little groups and quietly tell each other what they are doing. One asks how much do you get to the retort? another, how many feet do you make to the pound? another says, how many feet do you sell to the pound? and by comparing the answers to questions like these they all see how hard it is to bring results down to a common standard of comparison.

The statement of yield varies about as much as that of illuminating power. In many instances this difference is more apparent that real. The various sizes of retorts and the different amounts of leakage and condensation make the yield per retort or the make per pound indefinite. Just the same as the difference in burners, pressure, or photometrical apparatus make it difficult to compare illuminating power unless each particular item is specified. The real practical question by which the success of the administration of any gas engineer must be judged is, "How many feet do you *sell* for each pound of coal (or other material) carbonized?"—and then comes that other question which must be considered with it: What is the illuminating power of your product according to the *standard?* Provided the illuminating power can be brought to the same standard this will give every man the means of comparing the results of his operations with those of another on a common basis.

"What do you sell?" is the crucial test. If an engineer cannot give a satisfactory answer to this question, it is very certain that a series of questions will present themselves to him, which if he is a faithful man he will soon seek the necessary information to enable him to answer, or some other man will undertake the investigation for him. Another advantage of these gatherings is of a social nature; men become better acquainted with each other, they see things that are outside of their own horizon. They are brought in contact with each other and with facts that

they never would otherwise hear of. These may be small items in themselves, but they all count in the grand total of results.

We trust that the usefulness of these meetings may be extended and that the best minds in the business may be brought to act in harmony and with fuller force in developing and perfecting the gas manufacture of this country until by more improved methods of proceedure and the applications of science they may be able to show in the next twenty years an advance superior to that of the past. Times are dull just now, but this is the time above all others to arrange and develop improvements in order that when business does increase every thing may be ready and in order to meet the demand and get the fullest benefit thereof, and at the same time be able to reduce the cost of the product to the consumer.

MARKED DOWN.

We are glad to be able to chronicle the action of four of the leading gas companies in this city towards meeting the stringency of the times. As we have before stated it is not to be expected that the gas manufacturers of this country are going to escape the effect of hard times any more than any other interest.

The present price of coal favors this reduction of price, which makes gas as cheap in New York as it ever was, and no man can deny that the quality is much better. Good, honest seventeen candle gas, at $2·50 per thousand feet, certainly ought to satisfy any one as regards quality, and most people as to price. There are some, however, whose personal ends may be satisfied, or who think they can make small capital by raising a noise, who would never be contented with any price.

To many of these, perhaps, the lower the price the less they would *really* like it, if the true state of their minds could be determined. We trust that it may never be necessary to raise the price again; and we would be glad to see such an improvement in the modes of manufacture, etc., as would enable the price to go lower with a good profit to the companies, and a fair and necessary amount placed to the credit of the reserve fund to provide for wear and tear, extension of works and rebuilding, etc. But no amount of mere popular clamor would ever justify the managers of this large interest in departing from sound business principles; while the stockholders should be satisfied with a reasonable return for their investment on the other hand—no man would furnish capital for the business unless it was at least a paying one.

We trust that the depression now existing will soon pass gradually away, and as it does we feel confident that the increased consumption, at the lower price, will more than make up the difference.

From all over the country we hear reports of reduced price, and it may be looked upon as a sign of better times approaching. More economy and more skill must be used, but it will result in more business, which ought in time to reduce the price even lower.

PRIMITIVE GAS-WORKS.

We give our readers to-day a full description of the apparatus and process used by Mr. David Melville, of Newport, Rhode Island, in 1806, for making illuminating gas. It is evident, from the account that will be found on another page, that he was nearer to being right in his ideas than many who have obtained patents since.

We have taken pains to collect reliable and authentic data in this matter, and have no doubt that it will be of interest to our readers in this our Centennial Year.

We regret that we were unable to obtain more figures in this matter, but found that only a year or two ago the descendants of Mr. Lewis had destroyed a quantity of papers, figures, and drawings relating to these early efforts in gas-lighting, supposing that it was so long ago that they would be of no use.

We are indebted to Mr. George C. Mason, of Newport, for the facts and the drawing which we give to-day, it being an exact copy of one left by Mr. Mellville.

COAL-TAR PRODUCTS.

In the working up of the tar from gas works, the following may be taken as about the ordinary results obtained in actual practice:

100 Gallons Crude Coal Tar.

- 72·5 galls. Pitch
- 23·75 gallons heavy oil.... { 21·75 gals. creosote oil. / 2·00 anthracene.
- 3·75 galls. light oil ..... { 1·25 gals. benzole. / 1·875 " naphtha. / 0·625 " carbolic acid.

or, by percentages, the coal tar gives:

72·50 per cent. of pitch.
23·75 " " " heavy oil.
3·75 " " " light oil.

☞ The Price of Gas.—We desire to publish, at as early a date as possible, a correct list of the prices at which gas is sold by the various companies throughout the United States and Canada; and we would respectfully ask that each company would send us by postal card the price at which they are selling. In this way the information will be reliable, and gas managers throughout the country can see at a glance what the prices are in other places.—Ed.

The Use of Coke Screenings as Fuel.

In our issue of February 16th one of our correspondents gave our readers a detailed account of the method employed in using breeze (or coke screenings) under boilers, showing what the saving had been under one boiler. These facts are important and reliable, and we repeat to-day the figures then given.

To show the saving resulting from the use of breeze, I have taken the months of January for the past three years as an example of the use of screenings and the same months for the three years previous to that for that of coke.

USING COKE.

January, 1871	155 chaldrons.	
" 1872	133 "	
" 1873	111 "	
Total	399	
Average per month.	133 "	=4,788 bushels.

USING SCREENINGS.

January, 1874	126 chaldrons.	
" 1875	123 "	
" 1876	90 "	
Total	339	
Month's average	113 "	=4,068 bushels.
Saving in bushels	720 "	

The average weight of our coke is 41 lbs. p. bush. The average weight of our screenings is 43 lbs. per bushel.

The coke being measured "heaping" and the breeze being always a "struck" bushel.

Reducing our bushels to pounds we have

Of coke.....196,308 lbs.=133 chaldrons, and
" screenings...174,924 " =113 "

Saving..... 21,384 " for the month, or 690 lbs. of fuel per day=11 per cent.

Where it is not desired to use a blower, and the natural draft is not sufficient, some form of steam injector under the fire may be used to create a draft. We are informed that this has been done in Cincinnati with very satisfactory results.

Cooking by Gas.

The following are Mr. John Wallace's remarks as reported in the London *Jour. of Gas-Lighting*, which we promised in our last to give to our readers:

Prof. Bunsen discovered, that by mixing air with gas before burning it, a much smaller and hotter flame was obtained than before; and since he gave the world his discovery, hundreds of modifications of it have been made and applied, with more or less success, to an infinite number of purposes. The effect of mixing air with the gas is best shown by experiment.

I light the gas issuing from a pipe one inch in diameter, and you see a long, straggling, smoky flame. The gas will not burn alone, and as it is only by contact with the atmosphere that the combustion can be maintained, it spreads itself out so as to have a large surface. Inside, the flame is hollow for a considerable distance, and if a vessel of water or other cool substance were placed over it, a coating of soot would soon be deposited; but the moment I remove my hand from the air orifices at the base of the tube, the air rushes in, and the flame instantly contracts to one-tenth of its original size; and as all the heat the big flame gave off is now produced by the small one, the temperature of the flame is much higher. This flame deposits no soot, but, on the contrary, will burn it away from a coated surface.

Returning to the smoky flame, I coat a piece of tin plate with soot, which has been suddenly changed from the invisible and gaseous form into a wonderfully fine black powder; and now admitting the air, the flame shrinks and intensifies; the carbon is again transformed, and is now carbonic acid gas.

Bunsen, or atmospheric burners, no matter what their form is, all possess certain essential parts in common. There is a gas-jet orifice, and in close proximity one or more air openings. There is a chamber where the gas and air mix, and there is the outlet where the mixture burns.

Here is the simplest known form of Bunsen's burner. It consists of a straight upright tube with a gas-jet orifice at the bottom, and holes at each side of the jet through which air is drawn by the inductive force of the gas. On removing the tube and lighting the jet, the gas burns in a long pencil from the orifice, but when the tube or mixing-chamber is put on, the gas must burn at the top.

If the gas should light inside, then combustion is interfered with, and partially burnt gas begins to escape, producing the sickening smell which has brought the Bunsen burner so often into disrepute. The Patent Office bears witness to scores of inventions devised to obviate this defect, and it is my purpose to exhibit to you several forms of apparatus designed to avoid this most inconvenient tendency.

I shall now direct your attention to the appear-

ance of the flame, as it is in all cases an unfailing index of the value of the burner for practical purposes.

Not only must the proper proportion of air be mixed with the gas, but it must be mixed intimately; otherwise the flame will be irregular, produce a roaring noise, and be liable to light within on a slight change of pressure. The roaring appears to be caused by certain parts of the column of gas and air having an explosive proportion, while other parts have a less quantity of air. The explosions are so minute and so rapid as sometimes to produce a musical note. This may be cured in a common burner by lengthening the tube, and by other methods.

Another and more complete method may be employed to adjust the amount of air, as exemplified in the Cam burner.

At the base of the tube is a gas-cock, having an eccentric fixed on the plug or key, which lifts the air-slide in proportion to the amount of gas passing. The curves on the eccentric are so made that on one side of the maximum amount of air is admitted, producing an oxidizing flame; the other side admits just enough of air to produce a carbonic oxide or deoxodizing flame.

In all cooking operations gas, when properly applied, has many advantages over coal as fuel, and these advantages are rapidly commanding recognition. Cooking is a chemical process in which a certain amount of heat is made to act upon the food to be cooked. More heat or less heat than the required quantity results in bad cooking.

The heat of a coal fire is very irregular, and is liable to be affected by so many circumstances that much attention is necessary to keep it in the proper condition for delicate operations.

Moreover, the amount of heat produced by an ordinary kitchen fire is so great, in proportion to that requisite to do the necessary work, that the risk of burning and spoiling the food is much increased. The great merit of using gas is that you may obtain exactly the amount of heat you want and apply it in the manner best calculated to effect the desired object. Beside all this, its cleanliness, and the facility with which it may be used at all times, are advantages which no other fuel can offer.

The heating of water and air-baths is another purpose for which gas is admirably adapted, as it dispenses with a system of water-pipes which often give great trouble. The hot-air bath may be made ready for use in less than five minutes, and the temperature may be adjusted by the user to any point below 200° Fahrenheit. It also has this advantage over the Turkish bath, that the bather is not obliged to breathe the hot air, which frequently produces faintness. The cost of gas for this bath is one-third of a penny. The hot-air bath is an apparatus of great value, both in health and sickness, and is so simple in its construction as to be within the means of any skilled workman. A paper, such as the present one, would not be complete if it did not inquire into the cost of producing heat from gas, as compared with that from coal.

I shall therefore appeal to the best known authorities for data on which to base the calculation. Dr. Letheby and Mr. F. J. Evans, after careful experiments in 1866, found that 13 cubic feet of coal gas, when burnt, would produce as much heat as one pound of coal when completely consumed.

Dr. Neil Arnott, Mr. Edwards, the author of "Our Domestic Fireplace," and other authorities, agree in stating that, in the ordinary fireplace, of which the greatest number exist, only one-eighth of the total heat of the coal is utilized for heating purposes, the remaining seven-eighths go up the chimney. It follows, therefore, that eight pounds of coal would, under these circumstances, be required to produce heat equal to 13 cubic feet of gas, and their respective prices may be reckoned as follows:

8 lbs. of coal at, say, 16s. per ton will cost	·765d.
13 cu. ft. of gas at 3s. 4d. per M	·546
Difference	·219

The prices of coal and gas heat are, therefore, as seven to five roughly, or, in other words, that amount of heat, which, if obtained from coal, would cost 7¾d., would, if obtained from gas, cost 5½d. One-third of the gas-heat might now be sacrificed in order to carry away the products of combustion, without raising the cost of the gas-heat above that of the coal.

There are certainly many methods of using coal for heating purposes which are more economical than gas, but most of them are expensive to apply, and none of them possess the advantages of gas fuel. It should be an inducement to the public to know that the use of gas in the daytime is more likely than anything else to reduce the price of it, by giving more uniform occupation to the apparatus at the gas works.

It must be borne in mind that it is on the proper combustion of gas that the fate of its application to household purposes depends. The prejudice against the substitution of gas for coal in cooking is not difficult to overcome; its relative economy for that purpose is established beyond denial, and its convenience is equally admitted. But the sickening smell from badly constructed burners is past all endurance, and nothing can reconcile people to it.

It is a great pity that the gas companies, who have brought the construction of the gas-meter to such perfection, should have allowed the manufacture of gas-cooking and heating apparatus to fall into the hands of the most ignorant class of manufacturers, who are to blame for nearly all the bad repute attached to the system.

There are a few exceptions to this sweeping statement, but the numberless failures, particularly of burners constructed after Bunsen's principle, which must be present to the mind of every one who has had any experience of them, will bear out what I have said.

Gas companies are by degrees taking the matter in hand, because they find that it provides duty for their mains in the daytime, but the mischief is already done which it will take years to undo.

The increasing cost of household labor renders it highly probable that the same measure of success awaits the domestic application of gas as has already established the sewing-machine among our household gods, and had the gas apparatus been in equally competent hands, there is no doubt that it would long ere this have become one of our domestic institutions.

It is to be hoped that among the numberless schemes for gas manufacture which have recently been made public, we may soon be provided with a gas which shall be sufficiently cheap and plentiful, to be used not only for lighting and heating in private dwellings, but also for trade and manufacturing purposes in workshops and warehouses.

Gas is the perfection of fuel. It can be produced from materials unfit for burning in small fires or furnaces, it can be lighted in a moment, and burnt with the utmost regularity.

If we consider for a moment in what a very important relation the supply of light and heat stand to the daily requirements of our houses, it becomes evident that any really valuable improvement on our present system will contribute largely to the reduction of the cost of household labor, and help us on towards that Utopia of which we have lately heard so much and experienced so little.

Mr. Wallace, in answer to a question, explained the construction of his hot-air bath, heated by gas. The bath, he said, consisted of a small wooden frame, forming a square box. This was covered with calico on both sides, and there were two layers of paper between the calico, in order to divide the air-spaces into three. On the top was a light quilt, with a hole for the bather's head to pass through, and the whole apparatus folded up just as a screen would do. The bath was so constructed that one person could arrange and use it, and the heat was regulated by a tap, which was under the command of the bather. The bath was so cheap that it came within the means of any one; and it possessed this advantage over the Turkish bath—that the bather was not compelled to breathe the hot air.

Mr. Dreyfus said he was well acquainted with the principle of the Bunsen burner, but Mr. Wallace had shown them one of the simplest regulators he had ever seen. He should have liked, however, if Mr. Wallace had given them more explanation as to the structure of the flame. as that was a matter which would have been very interesting to the audience present.

Mr. Wallace said this reminded him that he had given too little attention to one of the most important parts of the subject. The difference between the flame he had shown them and the one ordinarily connected with the name of Bunsen was a matter of interest. It had been usually considered essential that the flame should have a hollow space within. The hollow space, however, was simply an indication that the gas had not sufficient air to consume it. If they gave a certain percentage of air to the gas before combustion, the flame was condensed, the hollow space disappeared, and they had a solid flame. The amount of air to be mixed varied with the diameter of the burner. The principal difficulty ithw large burners was that you must either burn less air and have a bad flame, or mix more and have an explosion; and, until the perforated cap he had shown them solved the difficulty, he had only been able to mix 1½ volumes of air. Mr. Wallace then, by means of experiments, showed to the audience the difference between the hollow and solid flame.

Mr. Bailey asked whether Mr. Wallace had found that any relative length or diameter of burner was the best.

Mr. Wallace replied that it was impossible to formulate any rule for the construction of burners. If he was working with only one kind of gas, he might be able to supply figures to discover the size, and the shape, and the amount of gas to be burned at a given pressure; but the pressure, and the quality of the gas, and the purposes of the burner varied so much that it was impossible to give any particular instructions as to the size of a burner, and he did not think it could be reduced to a rule. Every one of the burners he had exhibited required a different proportion, and this could only be found out by experiment.

Mr. Harrop said he had put gas burners to a practical test during the last few months, in the direction of heating a green house, and he found that a Bunsen burner and a properly constructed boiler gave out better results than a coal fire, for he had always one temperature. For the last few days he had been experimenting with one of Mr. Wallace's burners, and taking it for all in all, he thought it was the best that had yet been brought out.

Mr. Walker said it was over 12 months since he became acquainted with Mr. Wallace. At that time he was working a steam engine with a gas-burner; but he had a great deal of trouble with it. It worked moderately well while it was new but afterwards he had a good deal of soot, and he had considerable difficulty in getting rid of it. About that time he was introduced to Mr. Wallace, who put before him a burner which he had used with great advantage for a considerable time.

Melville's Gas Apparatus.

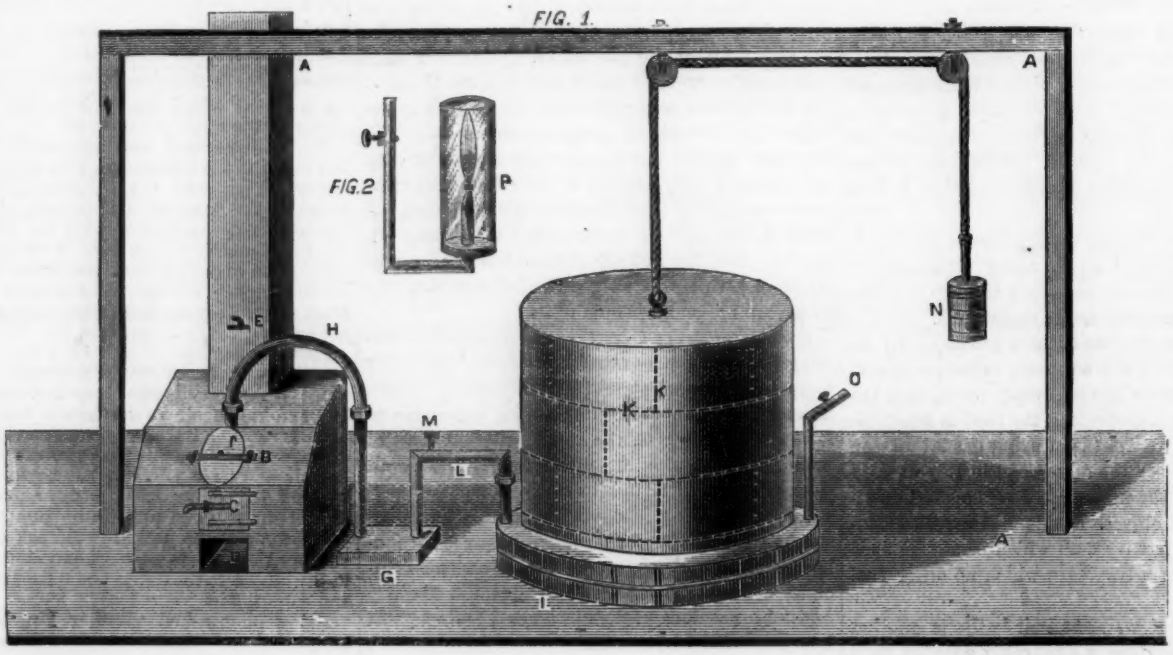
INVENTED IN 1805-6; IMPROVED IN 1810-12, AND PATENTED MARCH 18, 1813.

In our last we copied the advertisement of David Mellville's gas apparatus, taken from a newspaper under date of November 13, 1813, but the original advertisement appeared, we find, in February of that year; and as the history of that apparatus is very interesting, we propose to recall it for the benefit of our readers.

The first efforts to make gas for illuminating purposes were, as we all well know, anything but satisfactory in their results. They were begun by Murdock, at Redwith, Cornwall, in 1792, and were followed up for a number of years, until he finally realized his expectations. His experiments were all kept a profound secret, and the public were only advised, from time to time of the result. Of his process nothing was then known outside of his gas house. Previous to that time Lord Dundonald had set up some coke furnaces, and the gas generated in this way he burned for the amuzement of his friends; but nothing more came of his experiments, nor were they made for the purpose of benefiting either himself or the public at large. Murdoch continued his experiments, and in 1802 had so far perfected them that he was able to light, in part, a large factory near Birmingham. Nor was he alone in his efforts to solve the problem, for it had attracted the attention of Samuel Cleggs, who subsequently became eminent as a gas engineer, and who commenced a series of experiments in 1824.

Up to this time nothing had been done in America to make gas, for little could be known on the subject other than what could be gathered from the published reports, and these were very scanty and incomplete. They were enough, however, to arrest the attention of David Mellville, of Newport, R. I., who had a turn for mechanics and a fondness for experiments, and who at once gave his attention to gas making, beginning with a common clay pipe for a retort, and drawing off the gas through the stem. He soon found the thread he was looking for, and in time he solved the problem—solved it so well that in 1806—two years before gas was used for illuminating purposes in London—he lighted his house and the street in front of it with gas of his own manufacture. We will first describe his apparatus, of which we give an illustration, and will then refer to the practical results of his experiments.

FIG. 1.



"A A A, the floor and part of the structures of the gas house; B, a furnace, in which a retort is set; D, ashhole; E, damper or register, to regulate the draft of the furnace; F, a cast iron retort, with the door fixed on, in which the coal is put to produce the gas; G, condenser or bath; H, pipe which conducts the gas from the retort to the condenser or bath, where it passes several times through the water, by which it is washed and purified; I, cisterns set in the ground and kept filled with water, by means of an aqueduct, the water from which passes through the bath to a drain from the gasometer house; K, gasometer or reservoir, which is suspended in the cistern of water by a rope or chain leading over pullies: L, pipe which conducts the purified gas from the condenser, through the water in the cistern to the gasometer, where it is reserved for use; M, stop-cock to let off the gas until it becomes inflammable, and to burn it from, when the gasometer is full, to prevent its escaping underneath, N, a balance of weights to hold the gasometer in suspension, and (by taking off one or more of the weights) to give force to the gas when necessary; O, pipe which conducts the gas from the gasometer house to the apartments where the lights are wanted, where it issues from the burners, and on the application of a taper, will burn with a brilliant flame, without smell or smoke The burners are fitted with keys by which the flame may be regulated, or instantly extinguished, which operation may be performed on the whole at once (be there ever so many), by means of a single key in the main tube; P, the form of the burner from which the gas issues, with the glass tube, and key to regulate the flame."

The above is the description of the apparatus given in the application for a patent; and the following were the instructions for using it:

"A quantity of coal, in proportion to the number of lights required, must be placed in the retort, and the door screwed on and luted tight with a lute of clay and sand; this done, a strong heat being applied by means of a fire kept up in the furnace, hydrogenous gas, or inflammable air, will be driven out of the coal confined in the retort, and forced through the water in the bath; in which the condenser is immersed; by passing through the water the bituminous matter which is a component part of the coal is separated from the gas, which is washed and purified. As the gas passes in, the gasometer will be raised up until it is filled; when full (to prevent the escape of the gas underneath, and the smell which it occasions when it issues without burning) it may be burned from the cock on the pipe which leads from the condenser to the gasometer. When the lights are required, by taking one or more weights off the balance, the gasometer will bear with so much the greater force on the volume of gas contained in it, by which it will be propelled through the pipes to any distance, and in any direction to the burners, which are situated where the lights are wanted. Immediately on the issuing of the gas from the aperture of the burner, and coming in contact with the oxygenous gas of the atmospheric air, it will take flame on the application of a taper, and burn with a brilliant light without smell or smoke, as long as there is any gas in the gasometer. The burners are fitted with keys, by which each separate flame may be regulated to give more or less light at pleasure, or be instantly extinguished, and the whole (be there ever so many) may be regulated as to the size of the flame, or they may be instantly extinguished by turning a key in the main tube."

"The quantity of coal required for any given number of lights, will vary with its quality. The usual quantity is about forty pounds for fifty flames, equal to that of a mould candle of six to a pound, to burn three hours. Two pecks of coal, weighing forty pounds, put into the retort, will leave a residuum of near three pecks of coke, weighing twenty eight pounds. The coke is better for many uses than raw coal, and if used in the furnace, will be nearly sufficient fuel for each succeeding operation."

At the time that these experiments were made, Mr. Mellville was residing in his house on Pelham street, and directly opposite what was then known as Townsend's Coffee House, which was a great resort in those days, and the only hotel or tavern in the town. The first story of the building was used as a bath house, and was divided up into a large number of small bath rooms, each of which was lighted at night when wanted. The principal part of the house set off for the family had also to be lighted. In this house Mr. Melville made his experiments, and in the basement the first apparatus was set up. It was very defective of course. The tubes, of tin and copper, the wooden cisterns, and other imperfect features, gave him much trouble, but in 1806 he had so far succeeded that he was enabled to light more than twenty rooms on his premises; by means of a large lantern he lighted Pelham street as it had never been lighted before. The success was thought to be very great, and hundreds and thousands visited the house; many persons coming from distant towns and cities to see it. Frequently forty or fifty would come in of an evening for this purpose.

Wishing to turn his apparatus to account, Mr. Melville offered through the press to light dwellings and factories in the same manner, and soon had sundry applications. A contract was made with Hon. James De Wolf, of Bristol, to light the Arkwright factory, and also with the Wenscott Manufactory Company, both near Providence. Melville lacked capital and formed a partnership with Capt. Winslow Lewis, a constructor of lighthouses, doing business in Boston. The apparatus for each of these factories, and also for one at Watertown, were made in Boston, Lewis advancing the money. In each instance the apparatus was in every respect like the one in use in Newport, but on a much larger scale. After they were put in operation many complaints were made of a want of complete success. The gasometer of the Wenscott Company was found to he too small, giving only gas enough for two hours consumption instead of three; there was also difficulty in passing the gas from the condenser to the cistern, and finally there was an explosion. Mellville had given the workmen minute instructions in regard to the management of the apparatus, and warned them of the danger that would follow any departure from the rules laid down. But a heedless watchman, paying no regard to what had been said to him, entered the gas house with a light, and an explosion, disastrous in its consequences followed. The public became alarmed; Lewis who had advanced two thousand dollars, refused to go in any deeper, and the whole thing seemed likely to come to a complete stand. Nor were these the only obstacles to success. The expense of lighting was too high. The first charge was $10 per light, which was subsequently advanced to $12 and $13, and this was exclusive of transportation, and the cost of the necessary buildings and cisterns. Lewis complained of the want of confidence on the part of the public in the apparatus early in November, 1813, but before the year was out his faith revived, and he expressed a willingness to go on. Mellville had shown that the accident was wholly the result of carelessness, and for two years he kept his house lighted for the benefit of all who wished to test the process. The works in his own house were run by a boy of fifteen, who had entire charge of them. This apparatus was kept in order till 1817, and after the daily use of it was abandoned, it was frequently lighted for the benefit of strangers.

The same year, 1817, a contract was made with the United States (the oil contractors consenting) to build a gas house and put up an apparatus for lighting Beaver Tail lighthouse for one year. A double apparatus was thought necessary, for fear one might give out or break down, and they were fitted to make gas from tar and rosin, instead of "pit coal," heretofore used. So far as the lighting is concerned the project was a success; but it had its opponents, and one of the complaints was that at times the light seemed to be partially obscured. This was found to be caused by the frosting of the windows—a trouble which all lighthouses had had to contend with. Mr. Mellville took this matter up, and after experimenting found that by passing a small current of cold air up on the inside of the glass, the frost would not form. It was also said that the double apparatus would be difficult to manage, and that it would be far more difficult to make gas from the materials proposed than from coal; but a boy of fourteen, instructed by Mr. Mellville at the same time that he instructed the keeper, kept the works in good running order during the whole year. The expense for the year was nearly double the cost of lighting by the old process, but this was set down to the charge of the double apparatus; and it was shown that the actual running expenses made a saving to the government.

A year had gone by, and on the receipt of the report the whole matter was referred to Gen. Dearborn, Collector at Boston, with instructions to inspect the work, collect all the information he could, and to report to the Secretary of the Treasury. Gen. Dearborn accordingly visited the Beaver Tail light and examined into the lighting and the working of the apparatus; saw persons who resided from seven to twenty miles from the light, as to their being able to see it at night, and questioned sea-faring men who were frequently on that part of the coast. The report was favorable, and it recommended the use of gas for lighthouses, wherever it could be used conveniently. The report was accepted. The Secretary of the Treasury, in his letter to Mr. Melville, said that the government was perfectly satisfied, and that he had directed the Collector, Hon. William Ellery, to examine the accounts and pay them if found correct. Here the matter ended. The contract was not renewed, and the Secretary of the Treasury, in reply to an application, said the lighting by gas would be discontinued, or would not be renewed unless it should be found that oil had materially advanced in price, or that gas was the cheapest of the two. It was a contest between gas and blubber. The oil contractors and the owners of whalers made common cause, and blubber came in ahead. Mr. Melville had no capital to push the matter further, and so the works in the lighthouse were taken out and sold for what they were worth.

The facts here stated are well authenticated, surprising as they may seem. It is wonderful how the experiments were pushed to such results with such materials. What with his two pipes, his keys, fitted to such pipes, his wooden cisterns, imperfect gasometer, and his small retorts, it is surprising that he accomplished anything. But there is the evidence before us, and although we might make allowance for some leaning to his side on the part of those who had no particular interest in the result, other than that growing out of the novelty of the invention, there is still the report of Gen. Dearborn, and the Secretary of the Treasury's acknowledgement, that the apparatus had proved to be all that had been claimed for it by the inventor.

That the apparatus did work well in a small way is amply attested; but when the number of burners was materially increased, the difficulties attending the process were increased in the same ratio, and thus it was that the efforts to light large factories were only partially successful. Mr. Melville was evidently aware of this, for in some instances he declined to accept orders from distant places, evidently feeling that whilst works put up near his base of supplies, and by workmen he had already drilled, taxed all his resources, the labor would be infinitely greater when carried on in a strange place and with new hands to carry out his orders. We are not surprised, then, to learn that on the withdrawal of government patronage, Mr. Mellville retired from the business, and made no further efforts to introduce gas, either into public buildings or private residences.

Coal Gas.

[The following paper was sent to the Secretary of the New England Association of Gas Engineers, by Dr. M. W. Kidder, and was read by the Secretary at the late meeting in Boston. We give it to our readers, hoping that the various positions taken may be thoroughly studied and discussed.—Ed.]

In reviewing the history of the manufacture of this important commercial product, we find that though many improvements of a minor character have been made, yet the most prominent faults remain uncorrected however much thought may have been bestowed upon them.

The conviction has been general, among scientists and practical gas engineers, that the process, as usually pursued, was wasteful in an eminent degree.

I hope so fully to show not only the time and manner of the waste, but also its magnitude, as deduced from the statistical possibilities of the materials used, as to convince those who look for more light upon this subject of the importance of the suggestions herein made.

Both the apparatus and the process usually employed demand radical amendment.

I arraign the horizontal retort, for distilling coal and making gas as generally used, as an unfit device; it has wasted an immense material value, and can never be used for distilling coal with any other result.

The chief recommendation of its advocates is—that fifty years' experience with it has so taught them that they need no brains to run it, and muscle is cheaper than brains in any market.

But you must not overlook the fact that two dollars worth of muscle costs more than one dollar's worth of brains, and that the latter may produce greater and better results than the former, and at less cost.

The horizontal or slightly inclined retort is, however, the best possible device for converting the vapors distilled from coal into gas, as it takes the greatest advantage of the heat applied to it.

With the horizontal retort made of iron or clay very many experiments have been made—varying the pressure and temperature, introducing light or heavy charges of coal, also various proportions of different kinds of coal, using one end of the retort for distilling the vapors from the coal and the other for converting these vapors into gas; also, passing the vapors distilled in one retort through another, either empty or containing incandescent carbon at a high temperature, as well as others too numerous to mention.

One process, however, deserves especial mention, as it has yielded the best results ever reported from bituminous coal distilled in horizontal retorts.

I refer to the water-gas investigations of Frankland, fully reported in "Muspratt's Chemistry," and often referred to in other works, wherein the advantage from a large increase of the non-luminant gases is partially shown, raising the production from 12,000 to 36,000 cubic feet to the ton, and the increase in illumination nearly in the same proportion; also the Gwynne-Harris process, so-called, which is a modification of that used by Frankland.

In both cases, however, the horizontal retort has done all that was possible towards spoiling a good invention, to which was added the folly of attempting to supply the water gas directly from the generator, the product being exceedingly variable; and, if the coal was not at a sufficiently high temperature in the generator, the steam being in excess, would either pass unchanged or be converted into carbonic acid to mingle with the hydrocarbons from the bituminous coal, the result of which in either case, you see, would be to convert a portion of the carbon of the hydrocarbon vapors into carbonic oxide. It was not, therefore, found to be practicable or reliable in results.

Never, until the coal is better treated, will its capactity for yielding light be known, and all attempts to use a gridiron for a skillet will prove disastrous.

That we may fully understand the defects of the present process, let us go inside the retort and see what occurs while a charge is being roasted. The best time to enter is just after the coke has been drawn.

We find the temperature at 2,200 or 2,300°, in comes a long scoop filled with coal, and then another, and the mouth of the retort is closed.

Now, if we climb up on the coal, we shall be in no immediate danger of burning our boots, as the coal is of the same temperature as when in the coal sheds, and it will take a little time to get it warmed up.

The temperature of the retort has been so far depressed by the fresh charge of coal, and the large evolution of vapors from it, as to render it for a time almost incapable of converting these vapors into gas.

Where the coal lies against the retort a prodigious volume of hydrocarbon vapors is being forced out, and rising to the space above the coal, rushes for the stand pipe. A small portion of these vapors, in their passage to the retort, has been decomposed, while a large portion has been carried over into the hydraulic main, and is henceforth of no value in the gas—it is condensed into a liquid—and we call it tar.

The coal next to the retort and upon the top of the charge having become sufficiently heated to melt it, now forms an envelope about the coal.

This envelope of coke having parted with its vapors, becomes incandescent, and from thousands of pores like those of a sponge, jets of vapor are constantly forced from the enclosed portion of the charge.

Now, if we observe carefully, we shall find the quality of these vapors is constantly becoming changed, that there is an increasing quantity of hydrogen, marsh gas, and floating carbon, or soot.

What has caused this change, the coal was all alike? We will go to the centre of the charge and accompany the vapors and see what occurs on our way. We find at the centre the vapors of the hydrocarbons preparing to leave No free hydrogen, marsh gas, carbonic oxide or soot are here known, the temperature is not above 700°; we move on, it grows warmer as we approach the outer crust of incandescent coke, and, as we are about to pass, the coke says—"*Stop!* I never allow any hydrocarbon vapors to pass me if I can reach them. I'll divorce the hydrogen from the carbon, utterly, if they come near me."

There is no alternative, and the hope of the hydrocarbon that it might give light to the world is blasted—henceforth it must be classed among the non-illuminants.

A fact of common experience in gas-making is, that richer gas is obtained from light than heavy charges of coal in the retorts, if drawn at the proper time. This does not depress the temperature nearly so much, allows greater freedom for escape of vapors, with less exposure to incandescent coke, and affords a larger gas generating surface in the retort, which, with heavy charges, is quite too limited to be effective. Prof. Chandler, in his instructive address to the American Gas-Light Association, Oct. 20, 1875, as reported in the AMERICAN GAS-LIGHT JOURNAL, pointedly refers to this effect of the incandescent coke upon the hydrocarbon vapors in the retort.

Twenty years ago Leigh said in reference to this same point—"Let the present system of gas making be examined, and the true source of the hydrogen and carbonic oxide so invariably found in gas and constituting so large a portion of its volume will be seen."

It is known to many gas engineers that the passage of good standard coal or oil gas, in contact with incandescent coke, will so analyze the hydrocarbon vapors, as to wholly destroy the luminant power of the gas.

A familiar example is also presented in the ordinary tallow candle with its long unsnuffed wick in the flame, we have the hydrocarbon vapors analyzed, the candle gives but little light compared with the same candle with a short wick, although consuming as much tallow; we also have a considerable elimination of floating carbon or soot. The long red wick is doing to the hydrocarbon vapors of the tallow, just what the coke does in the retort to the same vapors from bituminous coal.

Need I multiply evidence upon a matter so clear? The verdict from all the evidence, then, is that all the non-luminant gases and the soot are the result of the decomposition of rich hydrocarbon vapors in contact with incandescent coke.

To proceed then. Let us suppose that we have treated a ton of Penn coal; what are our products as a good result of the old method?

We have 10,000 cubic feet of 17 candle gas, about 12 gallons tar, coke, etc., etc., in due proportion.

If we examine the specific gravity of the gas, it is about ·438—the composition, tabulated, would stand substantially thus:

	cu. ft.	lbs.	
Hydrogen.....	5·010	26·35	
Marsh Gas.....	3·810	162·03	
Carbonic oxide	·540	38·83	335·25 : 765 :: 438 : 1000
Hydrocarbons.	·390	89·00	
Nitrogen.....	·220	16·42	
Oxygen.....	30	2·62	
	10·000	335·25	

Let us look at the result carefully and see if we ought to be satisfied with it.

We have 227 lbs. of combustible, and 19 lbs. of incombustible non-luminant gases, saturated with 89 lbs of luminant hydrocarbon vapors. This same ton of coal by slow distillation, in a proper retort, would have yielded from 70 to 75 gallons of oil, weighing from 560 to 600 lbs. We shall find in the tar 60 lbs. non-volatile matter; deducting this, it will leave us about 500 lbs. of oil, very much richer than crude petroleum for making illuminating gas, and we have utilized 89 lbs. of the 500 lbs. for giving light, or 17.8 per cent.

Where is the balance? It has been torn to pieces to produce the combustible non-luminants, which by this method cost 82.2 per cent. of the cost of the coal used to produce them: thus 9-360 cubic feet of combustible non-luminant gases cost 82.2 per cent. of $7.50, or $6.16½.

Is not this rather extravagant, when equally serviceable non-luminants may be produced for 10 cents per thousand cubic feet? effecting a saving of 52 3-10 cents in every thousand feet.

What would oil gas makers say to such figures? Especially the oil and water gas as combined at New London, Conn., or Utica or Poughkeepsie, N. Y.

They will give you 20,000 cubic feet of 17 candle gas from the same quantity of fat inferior oil to that distilled from coal, as you see we have used but 89 lbs. for our luminants in 10,000 cubic feet while they confess to the use of 13 quarts of petroleum to each thousand, or about 225 lbs. for 10,000 cubic feet, showing the oil from coal to be worth nearly three times as much as crude petroleum for this purpose; yet the waste of the old method is so great, that illuminating gas of good standard quality is produced from petroleum at a much less cost than coal gas is now produced.

When the coal is rightly treated, you have for $7.50 sixty-five gallons of coal oil, worth nearly three times as much as petroleum and 1200 lbs. coke for fuel, with all the convenience and safety for carriage and storage. Petroleum can never compete with it; the cost of transportation of the oil alone would largely exceed that of an equal value from coal.

Now, as we use but 89 lbs. of the 500 lbs. of luminants from a ton of coal for 10,000 cubic feet of gas, what volume shall we render equally rich with nearly six times the weight of the same?

And with the cost of the non-luminant element at 10 cents per thousand, what will be the cost of the finished product, after deducting the value of the coke and using one-sixth of the present cost of labor and purification?

It has been strongly asserted, that the non-luminants in the gas are a fraud upon the public, being employed merely to dilute gas, otherwise none too rich to be profitably and conveniently burned for illumination. This view is clearly erroneous.

Nay, the prime factor in coal gas is the non-luminant element, in the proportion usually presented, being about 96 per cent. of the whole volume.

Why is this; if it gives no light what does the consumer want of it? It is quite as indispensable as the gas pipes through which it flows.

The pipes are the railway, the non-luminant gases are the cars, and the hydrocarbon vapors are the freight. The freight is what the consumer wants, but he wants it in such form that he can use it, and the non luminants being burned with the freight, a desirable result is obtained. But why is it desirable to have so large a proportion of non-luminants?

First.—Because the non-luminants carry to their fullest capacity of the various hydrocarbon vrpors obtained from the coal used. They will carry a smaller proportion always of the more luminant principles. For example, although the proportion of naphthaline vapors which these non-luminants will carry is very small, compared with the vapors of prophyl or benzol, yet it far exceeds these in luminiferous capacity.

Second.—Because of the greater convenience both to consumers and gas companies, in having gas of such standard as can be burned in large burners without liability to smoke, or become clogged by small particles of dust. Also to allow a sufficient efflux of the heat-producing element to raise the hydrocarbon vapors to a white heat.

Without the non-luminants the luminant element would be principally a liquid and not gas, and it would be quite impossible to use it for its present purpose.

The non-luminants are absolutely indispensable—we must have them; but don't decompose your rich hydrocarbons for the purpose of obtaining them, when you can procure them so much cheaper from steam as water gas.

I wish especially to impress upon your minds the all-important fact, that the non-luminants carry all the luminants of each and every grade produced by the coal, that is in their power to carry, in view of the exposures after production, to low temperatures and the various mechanical scrubbing or frictional influences with which it is brought in contact before reaching the burner. It is clear from this fact that you could convey a larger per cent. of luminant matter from your coal to the consumer, in a lower than in a higher standard of gas; as your condensation of the luminant matter would be proportionally less, having more of the non-luminant base to convey it. It must be evident to all practical men, that you may convey 12 candle gas through exposures, that would reduce 17 candle gas to 12 candle gas, without material impairment, and this will show why you cannot produce from coal of a given quality, gas of a higher standard: the non-luminants are saturated with such of the luminants as that particular specimen of coal is capable of producing and more they will not carry to please any of us. This fact leads us to the consideration of another very important matter, which is the use of gas for fuel, both for heating and culinary purposes.

We know why it is not now so used—the cost to the consumer forbids it. Now, if you would make 12 candle gas, and sell it as cheaply as possible, would it not come largely into use for fuel, and then your distributing pipes would be in use sixteen hours of the twenty-four, instead of three or four; moreover, larger burners would yield the desired light and not be liable to smoke.

A majority of the gas works which make 16 candle gas, deliver to many of their consumers now no higher standard than 12 candles, owing to the exposures and condensation in that season of the year when the larger quantity is used. If it now costs $1 per thousand to distribute gas through the pipes, and four times as much could be sent through the same pipes in twenty-four hours for the same expense, it would reduce the cost of distribution to 25 cents per 1000. Now, make the gas so as not to cost over 25 cents in the holder per thousand feet, and you can furnish it at a price satisfactory for fuel.

A word in regard to temperature. No proposition can be more self evident than the necessity of maintaining a uniform temperatere of the retort, if we would produce uniform results, but how entirely is this beyond the range of possibility, while the coal is introduced in the ordinary manner; a variation of 1000 to 1500 degrees is inevitable, and the variety of products illustrate this fact.

The danger to the retort from the same cause must be greater than all other destructive agencies combined. for while the top of the retort is but slightly cooled, the part, against which the coal lies must contract from lowering of the temperature on the introduction of fresh charges, and must constitute the chief cause of fracture.

After stating the effect of the exposure of rich hydrocarbon vapors to excessive temperatures, Muspratt agrees with Leigh "that there must be such a temperature as would yield the hydrocarbon vapors and olefiant gas and yet not decompose them; but it must be far below that at present employed in the manufacture of gas."

The investigations of Marchard are also in point. To sum up the objections to the present retort system they are as follows: Great inconvenience and expense in charging and discharging the retorts. With insufficient heat to destroy the hydrocarbons, abund-

ance of tar and little gas is produced. With sufficient heat to produce gas, the hydrocarbons in contact with the coke are analyzed or practically destroyed. Destruction of retorts from sudden changes of temperature. The unavoidable waste in charging and discharging. The absolute impossibility of maintaining nearly a uniform temperature, which is indispensable to uniform results.

Having thus briefly surveyed the old method and shown its defects, I will now endeavor to present a new method without these defects.

As the non luminants in illuminating gas are of the first consequence, and constitute so large a part of it, it is important for us to inquire from what source they may be obtained most cheaply. This has been answered from so many different points, by so many different operators, as to lead us fully to the conclusion that steam in contact with incandescent carbon is, so far as the present knowledge of man reaches the cheapest and most abundant source.

Illustrations have been numerous from 1833 to the present time. Many are successfully engaged in this manufacture both in this country and in Europe. The only practical difference between them being the consideration of convenience and economy. Some apply the necessary heat upon the outside of the generating retort only, others upon the inside only, others still outside and inside.

Again, of those who heat upon the inside while rousing the fires, the resulting gases are utilized wholly by some, partially by others, and yet again by others are wholly wasted. Attention to this point is an impartant one for economy.

The advantage of having the apparatus so inclosed as that it may receive heat upon the outside, rather than being so exposed as to loose heat from the outside must be apparent, as upon the high temperature of the coal depends the generation of the gas; thus by keeping up the temperature it enables us to use the apparatus a larger proportion of the time than otherwise would be possible.

By the best means known the product of hydrogen and carbonic oxide is about 125,000 cubic feet to a ton of anthracite coal, of which about 80,000 feet may be utilized as a base for illuminating gas; the balance should be used for fuel. Some object that this water gas will make the illuminating gas so heavy that they cannot get it through the pipes.

Well, it will finish off at about 540 specific gravity. Gas companies now supply all burners through the present pipes, why cannot they supply the same burners with heavier gas? For illustration, if the gas is so much heavier that the pipes will carry but 90-100 of the present volume, are not the burners reduced in the same proportion? But the consumer will not burn so much through the same burners—no; and the leakage of manufacturer and consumer will be reduced 10-100.

The effect of a reduction in the cost of any useful commodity is increased consumption; less care is taken in regard to waste, this is always anticipated when the price of gas is reduced. With an abundant supply of cheap non-luminants, we next look to the bituminous coal for light. Having a distilling chamber of sufficient capacity to hold 1500 pounds of coal connected with a gas-making retort, we kindle the fire under the gas retort, and allow the flame from the fire to pass around the distilling chamber containing the bituminous coal; the vapors of the hydrocarbons are driven out, and in their passage to the gas retort are met bp the non-luminant gases as they are driven from the water-gas holder, in such proportion as will suitably dilute the rich hydrocarbon vapors, and constituting as before stated, about 96-100 of the volume of the resultant gas.

This mixture is then passed through the gas-producing retort, which is maintained at such temperature as is best adapted to combine all into a proper illuminating gas.

The coal may be introduced to the distilling-chamber and coke removed without the admission of air, and the labor of stoking reduced to the simplest proposition—one retort doing the work of from six to ten, and containing neither coal nor coke, is easily kept at nearly a uniform and suitable temperature to produce gas, and yet below the usual high temperature at which, in contact with incandescent coke, the luminants, as such, are destroyed. The gas thus produced will differ in no essential particular from ordinary coal gas, excepting as the ingredients of carbonic oxide is in greater proportion the temperature of the flame will be higher, thus insuring the more perfect combustion of the gas and a whiter light.

As the hydrocarbons from coal are so much richer in luminant properties than petroleum, and, therefore, a less weight required per thousand for the same candle power, the specific gravity of the resultant gas will be about 3-100 less than if petroleum was used in place of coal oil, giving us gas of 540 to 545.

Gas of less specific gravity may be obtained by converting a portion of the carbonic oxide into carbonic acid, and removing it by lime (as has been done before) so as to reduce the volume of carbonic oxide to from 2½ to to 6 per cent. of the mixed gas; but this involves a larger cost, and produces a gas in which the heating element is comparatively less—beyond this it would simply be a question of economy.

Do you ask, "Has the proposition as herein set forth been demonstrated in practice?" The answer is "Yes" and "No."

It has been demonstrated in its several parts, ta wit:

1st. The capacity of gas coals for producing oil.

2nd. The actual ingredient of that oil which is incorporated with coal gas, and upon which its light depends.

3rd. The source of the soot and of non-luminants now found in gas.

4th. That water gas, so called, may be successfully substituted for the present non-luminants made from the hydrocarbon of the coal.

5th. That stratification is a fallacy not to be entertained for a moment, in view of the immutable law of diffusion of gases.

The combination of these several parts in apparatus of practical dimensions has not been made; but why should they not be?

In all these words I have but presented in a practical form what has been foreshadowed in the expressed opinions of scientific and practical men for the past twenty years, and earnestly hope it may lead to a long and much needed reform.

Moses W. Kidder.
47 India street, Boston.

The Influence of Gas and Water-Pipes in Determining the Direction of a Discharge of Lightning.

Although the invention of the lightning conductor is one of the noblest applications of science to the wants of man, and its utility has been established in all parts of the world by the experience of more than a century, yet a sufficient number of instances are recorded of damage done by lightning to buildings armed with conductors to produce, in the minds of some, an impression that the protective influence of lightning conductors is of but questionable value.

The destruction by fire of the beautiful church at Crumpsall during a thunder storm on the morning of the 4th of January last, has induced me to bring before the society, with a view to their being known as widely as possible, some facts connected with the electric discharge which have guided me for some years in the recommendation of means by which disasters of this kind may be averted.

For the proper consideration of this subject it is necessary to make a distinction between the mechanical damage, which is the direct effect of the lightning stroke, and the damage caused indirectly by the firing of inflammable materials which happen to be in the line of the discharge.

Instances of mechanical injury to buildings not provided with conductors are still sufficiently numerous to illustrate the terriffic force of the lightning stroke, and at the same time the ignorance and indifference which prevail in some quarters with respect to the means of averting such disasters; for wherever lofty buildings are furnished with conductors from the summit to the base, and thence into the earth, damage of the mechanical kind is now happily unknown.

Even in those cases where lightning conductors have not extended continuously through the whole height of a building, or where the lower extremity of the conductor has, from any cause, terminated abruptly at the base of the building, the severity of the stroke has been greatly mitigated, the damage being limited, in many cases, to the loosening of a few stones or bricks.

The ever-extending introduction of gas and water-pipes into the interior of buildings armed with lightning conductors has, however, greatly altered the character of the protection which they formerly afforded, and the conviction has been long forced upon me, that, while buildings so armed are effectually protected from injury of the mechanical kind, they are more subject to damage by fire.

The proximity of lightning conductors to gas and water mains, as an element of danger, has not yet, so far as I know, engaged the attention of electricians, and it was first brought under my notice at Oldham, in 1861, by witnessing the effects of a lightning discharge from the end of a length of iron wire rope, which had been fixed near to the top of a tall factory chimney, for the purpose of supporting a long length of telegraph wire. The chimney was provided with a copper lightning conductor terminating in the ground in the usual manner. In close proximity to the conductor, and parallel with it, the wire rope descended, from near the top of the chimney, for a distance of 100 feet, and was finally secured to an iron bolt inserted in the chimney about 10 feet from the ground. During a thunder-storm which occurred soon after the telegraph wire was fixed, the lightning descended the wire rope, and, instead of discharging itself upon the neighboring lightning conductor, darted through the air for a distance of 16 feet, to a gas meter in the cellar of an adjoining cotton warehouse, where it fused the lead pipe connections and ignited the gas. That the discharge had really passed between the end of the wire rope and the lead pipe connections, was abundantly evident from the marks made on the chimney by the fusion and volatilization of the end of the wire rope, and by the fusion of the lead pipe. As the accident occurred in the day time, the fire was soon detected, and promptly extinguished.

Another and equally instructive instance of the inductive influence of gas pipes in determining the direction of the lightning discharge occurred in the summer of 1863, at St. Paul's Church, Kersal Moor, during divine service. To the outside of the spire and tower of this church a copper lightning conductor was fixed, the lower extremity of which was extended under the soil for a distance of about 20 feet. The lightning descended this conductor, but, instead of passing into the earth by the path provided for it, struck through the side of the tower to a small gas pipe fixed to the inner wall. The point at which the lightning left the conductor was about five feet above the level of the ground, and the thickness of the wall pierced was about four feet; but beyond the fracture of one of the outer stones of the wall, and the shattering of the plaster near the gas pipe, the building sustained no injury.

That the direction of the electric discharge had, in this case, been determined by the gas pipes which passed under the floor of the church, was evident from the fact that the watches of several members of the congregation who were seated in the vicinity of the gas mains were so strongly magnetized as to be rendered unserviceable.

The church at Crumpsall is about a mile distant from that at Kersal Moor, and the iguition of the gas by lightning, which undoubtedly caused it destruction is not so distinctly traceable as it is in other case which have come under my observation, because the evidences of the passage of the electric discharge have been obliterated by the fire. From information, however, communicated to me by the clerk in charge of the building as to the arrangement of the gas pipes, the most probable course of the electric discharge was ultimately found.

The church is provided with a copper lightning conductor which descends outside the spire and tower as far as the level of the roof. The conductor then enters a large iron down-spout, and from thence is carried into the same drain as that in which the spout discharges itself. Immediately under the roof of the nave and against the wall, an iron line of gas pipe extended parallel with the horizontal lead gutter which conveyed the water from the roof to the iron spout in which the conductor was enclosed. This line of gas-piping, though not in use for some time previous to the fire, was in contact with the pipes connected with the meter in the vestry, where the fire originated, and was not more than three feet distant from the lead gutter on the roof. As no indications of the electric discharge having taken place through the masonry were found, as in the case of the church at Kersal Moor, it seems highly probable that the lightning left the conductor at the point where the latter entered the iron spout, and by traversing the space between the leaden gutter and the line of gas-piping in the roof,

found a more easy path to the earth by the gas mains than was provided for it in the drain.

In my experiments on the electrical condition of the terrestrial globe I have already directed attention to the powerful influence which lines of metal extended in contact with moist ground exercise in promoting the discharge of electric currents of comparatively low tension into the earth's substance, and also that the amount of the discharge from an electro-motor into the earth increases conjointly with the tension of the current and the length of the conductor extended in contact with the earth. It is not, therefore, surprising that atmospheric electricity, of a tension sufficient to strike through a stratum of several hundred yards thick, should find an easier path to the earth by leaping from a lightning conductor through a few feet of air or stone to a great system of gas and water mains, extending in large towns for miles, than by the short line of metal extended in the ground which forms the usual termination of a lightning conductor.

It deserves to be noticed that in the cases of lightning discharge which I have cited, the lightning conductors acted efficiently in protecting the buildings from damage of a mechanical nature—the trifling injury to the church tower at Kersal Moor being directly attributable to the presence of the gas pipe in proximity to the conductor. Nor would there have been any danger from fire by the ignition of the gas if all the pipes used in the interior of the buildings had been made of iron or brass instead of lead; for all the cases of the ignition of gas by lightning which have come under my observation have been brought about by the fusion of lead pipes in the line of discharge. The substitution of brass and iron wherever lead is used in the construction of gas apparatus, would, however, be attended with great inconvenience and expense, and, moreover, would not avert other dangers incident to the disruptive discharge from the conductor to the gas and water pipes within a building. I have therefore recommended that in all cases where lightning conductors are attached to buildings, fitted up with gas and water pipes, the lower extremity of the lightning conductor should be bound in good metallic contact with one or other of such pipes outside the building. By attending to this precaution, the disruptive discharge between the lightning conductor and the gas and water pipes is prevented, and the fusible metal pipes in the interior of the building are placed out of the influence of the lightning discharge.

Objections have been raised by some corporations to the establishment of metallic connection between lightning conductors and gas mains, on the ground that damage might arise from ignition and explosion. These objections are most irrational, as gas will not ignite and explode unless mixed with atmospheric air, and the passage of lightning along continuous metallic conductors will not ignite gas even when mixed with air. Moreover, in every case of the ignition of gas by lightning, the discharge is actually transmitted along the mains, such objections notwithstanding. A grave responsibilty, therefore, rests upon those who, after introducing a source of danger into a building, raise obstacles to the adoption of measures for averting this danger.

Chemistry of Explosive Agents.

Modern chemistry has brought to light several explosive compounds of such extraordinary character that they have produced in the popular mind a great degree of interest. It is true, however, that the number of new explosive compounds which attracts public notice is very small, compared with the number fabricated by chemists or known to exist. The frightful nature of many of these agents renders them extremely hazardous to handle, and their fabrication is attended with great peril. Such are chloride of nitrogen and iodide of nitrogen. These bodies are so sensitive that a breath of air will explode them with extreme violence. The fulminates of silver and mercury are less sensitive, but slight friction disturbs the equilibrium of the particles, and they detonate with a force which rends asunder everything brought in contact with them.

An explosive body must be composed of constituents which will, on explosion, form large quantities of permanent gas, and they must be so associated that the reaction can be rapidly brought about, and will proceed with great rapidity and energy. Whenever a solid or a liquid body by sudden decomposition passes into the gaseous condition, great expansive force is developed, and explosion results. Nearly all explosive bodies are composed of carbon, nitrogen and oxygen. The carbon unites with the oxygen to form carbonic acid gas, and the nitrogen is set free in the gaseous condition. Carbon and oxygen readily combine, and the combination is attended with a great evolution of heat, and this heat is an important agent in increasing the force of the explosion. If a gun is charged with an ounce of gunpowder, and flame is applied, decomposition at once occurs in the solid grains, the elastic volume of the carbonic acid and nitrogen gases liberated seeks liberty, and, held in restraint by the iron tube, they push before them the shot or bullet with great force, because in that direction there is the least resistance. In addition to the expansive force of the gases, the atmospheric air entangled in the spaces between the grains of powder is greatly heated and expanded, and thus the force of the explosion is augmented by the mechanical energy of the heated air. It will be found that the dull negative element nitrogen, is an almost indispensable agent in explosive compounds, and in this fact we have a remarkable instance of the contrarieties of character which some of the elements are capable of manifesting. All the combinations of nitrogen are feeble, owing to the negative nature of the element. With oxygen it combines, but the affinity is so slight that it is readily dissevered in the presence of carbon, and it assumes its naked elementary condition. In gunpowder we have the nitrogen in the saltpeter used; in nitroglycerine we have it from the nitric acid employed in the manufacture; in iodide of ammonia a most explosive agent, we have it from the ammonia. Nitrogen in itself is a harmless body, and although it is capable of holding in its embrace elements which when set free are as terrible as the thunderbolt, it comes out of the most awful concussions simply as nitrogen. Nitrogen serves to closely associate together particles of carbon and oxygen before direct combination takes place, and also it helps in increasing the volume of heated gases produced in explosions.

There are explosive mixtures and explosive compounds, and a distinction should be made between them. Gunpowder is an explosive mixture, but nitro glycerine is not. In the former, the ingredients are mechanically mixed together, and can be separated by mechanical means; in the latter, the elements are in chemical combination, and cannot be separated unless by chemical change. The ingredients of gunpowder are not explosive when used separately; to obtain explosive force, they must be mixed. There are, however, some mixtures which contain substances in themselves explosive. The salts of picric acid are of this nature. A picrate has a certain quantity of oxygen available in the explosive action, but not enough, so it is mixed with a substance supplying oxygen, such as saltpeter or potassium chlorate. Nitroglycerine, dynamite, giant powder, etc., are essentially the same thing, and on explosion are resolved entirely into the gases, carbonic anhydride, water, nitrogen, and oxygen. If the explosion is perfect, the nature of the decomposition is as above given; but if it is imperfect, oxides of nitrogen are formed, and the force is diminished. When the explosion is perfect, no poisonous or disagreeable gases are given off, but otherwise they may be dangerous. The relative force of nitro-glycerine is not easily estimated, as the effect produced depends greatly on the circumstances. Thus, a charge of the agent in wet sand, or other soft material, will exercise but a slight effect, while the same charge in the hardest rock will shatter many tons. Roughly estimated, nitroglycerine may be said to be eight times as powerful as gunpowder, weight for weight.—*Boston Journal of Chemistry.*

Gas Works Engineering.

BY ROBERT BRIGGS, C. E.

[From the "Journal of Franklin Institute."]

In a previous number of the JOURNAL (that for October, 1875, vol. C. page 242), will be found a specification for a telescopic gas holder with crown top, which was prepared methodically so as to make a full specification in the briefest words. To complete the presentation of construction of gas holders, a similar specification is now offered for a single lift gas holder with flat top.

Without entering into the discussion of the question of flat top holders (which the writer has been planning and building since 1851), it will be simply stated that at 60 feet in diameter, and below, the advantages of durability, freedom from accident, light weight, and above all, prime cost, are so decided that no argument is necessary. Above 80 feet in diameter some considerations of construction so affect the cost, that the predispositions of superintendents of gas works may influence the engineer or contractor in favor of a crown top holder.

These flat top holders require no internal framing to carry the top when the holder is landed, and especially not a central pier support. If the top is permitted to hang by the curb freely, it can be relied upon to carry, not only its own weight, but also the weight of a foot of wet snow; 8 or 10 inches of water in the form of a plano-convex lens; 15 or 20 men; or any other load of necessary character, and yet not be strained by tension on the iron of the sheets, between the rivets, above the working tensile strength of 11,000 to 12,000 lbs. per square inch.* The only disturbance of the parts of such a holder when it lands, is the falling in of the top carriages at that time, so that the wheels leave the guides: but upon inflation of the holder this derangement adjusts itself, and the rollers find their place anew. This subject of the strength of the flat top crown may be reverted to at another time.

As the contents of an open top cylindrical vessel bear a maximum ratio to the surface of the sides and bottom (the envelope being supposed to be of equal thickness throughout), when the sides are one fourth of the diameter, so there also exists a maximum ratio between the contents and the weight of the envelope of a gas holder, in which the crown has one thickness and the sides another, with curbs, legs and all considered. which ratio determines the proper height of the side of a gas holder as compared to its diameter. In the gas holder question, the tank and its cost, form a part of the problem, and the proportions should be fixed so as to give the largest contents for gas for the smallest expenditure on holder and tank together. It has been found that if the height of sides be taken to be $0.28d+3.2$ that a scale of heights for given diameters ($=d$) will be found, which scale, a comparison of examples actually taken out, will be seen to nearly fulfil the conditions; as follows:

Heighth, 5·44, 6·0, 6·56, 7·12, 7·68, 8·8, 9·92, 11·04, 12·16, 13·28, 14·40, 15·8, 17·2, 20·0.

Diameters, 8, 10, 12, 14, 16, 20, 24, 28, 32, 36, 40, 45, 50, 60.

It will be found practicable to bring the weight of the iron work of holders built to these proportions to 2½ inches of water pressure, and when the thicknesses, etc., thus found, are examined, they will exhibit such dimensions as will satisfy the most critical in proportion of parts. The following specification shows the dimensions for a 60 foot holder.

SPECIFICATION FOR A SINGLE-LIFT GAS HOLDER.
FLAT TOP CROWN.

For ———————————————————

Working contents of holder 5654 cubic feet. (Allowing six inches submersion of sides when up.)

This holder will have a weight of 2¼ inches water pressure.

*The assumed loads for top of holder have been taken at maximums of actual occurrence, by accident or otherwise.

CROWN.

Curb Sheets, (Width, 2 feet 0 inches. (Thickness,* No. 10.

Remaining sheets of crown, No. 12.

SHELL.

(Upper and Lower) Curb Sheets, (Width, 2 feet 0 inches. (Thickness, No. 13.

Intermediate sheets, thickness, No. 15.

Upper curb, angle iron, 4″ × 4″ × 7-16″.

Lower curb, angle iron, 3″ × 3″ × 3-8″.

12 legs, T shape to be built of 2—1½″ × 1½ × 3-16″ L with a web of 5″ × ¼″ flat, and to have a backing plate of flat iron 3¼″ × ⅜″ on outside of section, countersunk riveted.

12† chord ties, 2″ × 1¼″ flat iron, to lower curb, running from each leg to foot of second leg, and riveted to curb and at intersections.

The splices, gussets, thickening plates (where brackets are attached) etc., to be of suitable dimensions. Manhole on crown of holder.

6 carriages, with base plates and guide wheels on top of holder.

12 carriages, with rollers on lower curb.

Two coats of metallic paint to be applied, one before shipment and one after erection; the latter coat on inside and outside of holder.

HOLDER FRAME.

6 cast iron columns, with base plates, placed at equal distances around circle formed by the tank, which shall be 62 feet 2 inches inside diameter.

The entablatures to be 1 foot 8 inches high, and securely clamped to capitals.

6 wrought iron lattice girders, 1 foot 8 inches high, connecting columns together at top, composed of two pieces of angle iron.

2½ inches × 2½ inches × 5-16 inch at top and bottom with flat iron, 1⅔ inches × ¼ inch, crossed and riveted to angle iron, and at intersections.

Girders firmly bolted to entablatures.

12 tank guides, of cast iron, with hoop iron anchor strips, to be built in brick work of tank.

Each column to have 2 foundation bolts, 1¼ inches diameter, and 6 feet 6 inches long, to be built in tank wall, and secured by cast iron washers, 12 inches × 12 inches × 1¼ inches thick in centre of washer.

Cast iron pipes, as per drawing, for 8 inch inlet and 10 inch outlet to tank of holder, with two drip boxes, 14 and 16 inches diameter × 27 and 36 inches deep, with hand pump for same.

Two coats of metallic paint to be applied on all exposed surfaces of the holder frame, one before shipment and the other after erection.

The whole of the work specified to be delivered at

It is stipulated that the tank shall be kept dry by the gas company, and that lumber for scaffolding shall be provided by them. The erection of and removal of which shall be done by the builder, and the material shall be used without unnecessary waste, and, on completion of the holder, be carefully piled upon the adjacent ground.

All carpenter work, masonry, excavation, and the placing of inlet and outlet pipes, and setting of foundation bolts and washers, and of tank guides in wall of tank, shall be done by the gas company.

All material to be of the best quality, and the work done in first class manner, subject to the inspection, and to be completed to the satisfaction of the engineer of the gas company.

Water for Bayonne.—The committee of the Board of Councilmen of Bayonne N., J., have made an examination of the water works in Long Island City, and they will now proceed to Rahway, where there is a similar plan for supplying water. It is proposed to build a large well, from which water will be pumped and forced through pipes into every section of the city. Hydrants will be placed at convenient intervals, and to these hose will be attached in case of fire. It is claimed that the expense of costly water works and of a fire department will thus be avoided.

* Refers to Birmingham Wire Gauge.
† Chord ties are not requisite except in windy location.

Modes of Lighting.

BY BISHOP CLARK, OF RHODE ISLAND.

No creature but man has ever managed to furnish himself with artificial light. Some animals and birds like the cat and the owl, can see remarkably well in the dark, and there are insects, like the fire-fly and the glow-worm, that help to make it a little lively in the country after dark; but no dumb being ever yet kindled a fire, or lighted a lamp. Man must have existed for a while without any artificial light; and I imagine that he had rather a dull time, roosting up in the tree, or crouching in his damp cave, after the sun had gone down. To be sure, there were no books or papers to read, and men can talk in the dark as well as in the light: but, then, in those days there could not have been much to talk about.

It was a great era in the history of the race when the first pine torch was kindled and the first lump of fat utilized for purposes of illumination. The smoke may have been an annoyance, and they could not get a very steady light from the resinous wood and the saturated bark fibre; but it was better than nothing, and answered well enough, so long as they had no elaborate toilet to make and no fine sewing to do. In process of time great improvements were made in this department of domestic economy, and among the relics of antiquity dug out of the earth and discovered in tombs, nothing is more common than the earthen or metallic lamp, frequently adorned with fanciful designs, and fashioned in forms of singular beauty; and, in fact, the most fashionable patterns now in use are copied from the antique.

Until near the beginning of the present century no special change had been made in the construction of the lamp, and in my boyhood we used to study our evening lessons by the dim light of a small round wick, that only served to make darkness visible. When the first astral lamps ever introduced into the town were mounted on the pulpit of one of our churches, their brilliant flame attracted everybody's attention and admiration. Many of our readers can recall the time, when, as the shades of night descended, the ghostly figure of the lamplighter glided through the city streets, bearing his flaming torch—for, in those days, there was no other resource but the flint and steel, and to have stopped at every post to "strike fire," would have used up a large part of the evening. I hardly think that we appreciate the improvements in our modes of lighting, which have followed each other so rapidly during the present generation. In addition to all the new mechanical inventions, consider how many new materials for general lighting have come into use.

What would become of us if the wax and tallow and whale oil to which we were restricted fifty years ago, were the only materials now available for the production of artificial light? The products of the bee-hive and the bay-berry bush would be of no account; at the present price of mutton and beef, tallow candles would go but a little way in supplying the general demand; and long before this the whales would have been exterminated. Darkness must have reigned in many a dwelling, our great mills have closed at sunset, and public assemblies, operas, and theatres have assembled by daylight, as they did in former times; or have been content with such a dim and dreary illumination, that the display would have been robbed of its charms. But, as the whales gave out the swine of Ohio were *pressed* into the service, and, for a time, lard-oil seemed likely to meet the universal want. The race of pigs, however, has its natural limit, and so there were invented all sorts of burning fluids, clean, cheap, and brilliant—and these had their run, liable only to this objection, that some of them were so explosive as to make them about as dangerous for lighting purposes as gunpowder would be for fuel. In our larger towns and cities, these were soon superseded by gas. It does not seem very long ago, when I went one evening in Boston, to see a public exhibition of this wonderful phenomenon.

Few people dreamed of the revolution it was destined to effect. Neither was it introduced into use without much difficulty and opposition. There is a document in existence, signed by most of the leading citizens of Philadelphia, earnestly protesting against its introduction there—urging that it must destroy all the trees and foliage, expose the people to constant peril, and vitiate the atmosphere to such an extent as to make the city uninhabitable, and render real estate valueless. On the first Sunday after the gas-fixtures were exposed in one of the churches, a sensitive lady fainted away, not being aware that the gas had not at that time been introduced into the pipes. It would have astonished our venerable ancestors if they had been told that their ambitious and daring posterity would ever have ventured to manufacture lightning by chemical and mechanical processes, and use that for artificial light. Such a prediction would have shocked their minds as painfully as the electric battery shocks the body.

How much farther we are destined to go in this direction, no one can tell. Sunbeams have not as yet been extracted from cucumbers, but it is thought by some that we shall find out how to turn the water which they contain into light. Perhaps, in another generation, no lamps will be needed in our streets; but, after the natural sun has gone down, great calcium orbs will be lighted in the air, shedding their radiance over the city, and turning night into day. What a contrast this would be with the olden times, when link-boys lighted pedestrians through the slippery streets of London, and flambeaus blazed around the steps of the theatres!

Thus far, I have said nothing of petroleum, the old Seneca oil of the Indians, that was once soaked up in blankets, from the surface of the rivers on which it floated, bottled, and sold as a drug, and which now itself flows as a river, carrying light to every quarter of the earth. How different is the aspect at night of our towns and villages since this brilliant illuminator has begun to shine from windows where once the sputtering candle and the smoky lamp struggled faintly with the darkness. No further need is there of calculating the cost of what is burned, no further need of putting out the lamp and trying to work and read by the glow of the flickering embers. It was a great day for the world when the man first "struck oil." They thought that it was a great thing when they were able to extract it from coal, but now, they find out that the whole thing has been done ready to their hand, in the great laboratory of Nature.

Is there not a providence in all this? It is indeed by human skill and human research that these inventions and discoveries have been accomplished; but is there no superhuman spirit that prompted man to do all this, just at the time when the world must have stopped in its onward progress, if the coal-beds and fountains of oil had not been revealed?—*New York Ledger.*

Apparati— A new anti-incrustator has lately been introduced under the name of apparatine, which is prepared by stirring up 16 parts of potato starch in 76 parts of water, and then adding eight parts of potash or soda lye, at 25 Baume, the whole to be thoroughly mixed together. In a short time the mixture forms a thick jelly, and it is then beaten up vigorously for a time, when it forms a colorless, transparent substance, slightly alkaline to the taste, and of a strong glue like consistency. It dries slowly in the air, without decomposition, and when perfectly dry resembles horn, but is more flexible. When introduced in small quantity into steam boilers, it prevents their incrustation. It is also capable of nearly all the applications of ordinary gelatine, and is especially adapted for sizing textile goods of all kinds, imparting to them a hitherto unattained smoothness. When once applied to goods dried, it is perfectly insoluble, as three or four washing in hot water have proved to have no effect upon it. It can also be used as a thickening in calico printing. Several of the technical journals speak of this substance as a very important addition to the resources of the dyer and manufacturer. Care must be taken to retain it in air-tight vessels until it is used, as it is not easily rendered soluble again when it once becomes hard.—*Iron Age.*

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THURSDAY, MARCH 2, 1876.

The Louisville Gas Company.

The Board of Directors of the gas company held their annual meeting at the office of the company, for the purpose of electing officers and a new directory for the ensuing year. President J. Lawrence Smith called the meeting to order, and asked for the reports of the various officers and committees.

The reports of the inspector and superintendent were read and received, and that of the treasurer postponed until the next meeting.

In his regular semi-annual report as President and engineer, Prof. Smith reported the condition of the company both flourishing and prosperous in all its relations.

The next business in order was the election of a new Board of Directors. Mr. J. W. Barr, the attorney of the company, declined to serve as a director, and Mr. Henry Whitestone was elected in his stead. After a time the following gentlemen were nominated and elected:

Thomas L. Barret; Henry Whitestone; B. F. Guthrie; William C. Hite; Isaac Wolfe; J. H, Deuchen; John P. Morton; Dr. R. C. Hewett; Prof. J. Lawrence Smith.

Upon the nomination of President, Prof. J. Lawrence Smith tendered his resignation, and carrying out the intention that has been known to the Board for two years, refused to be a candidate for that office. He expressed his gratitude, but firmly objected to having his name used in that connection. He suggested that Mr. Henry Whitestone would fill the office with credit, and nominated him for that position. Mr. Whitestone was unanimously elected, as was Mr. T. L. Barret to the chair of Vice President. The meeting then adjourned to meet in February.

Prof. Smith's reasons for resigning the position of President of the gas company are strictly of a business nature. He wishes to devote more of his attention to scientific pursuits, both in pure science and as an expert. He has held the office for fourteen years in the ducal capacity of President and engineer. All the plans for extensions and enlargements, and the superintendence of the execution of the same has come under his special notice. During his term of office the work has increased in size and extent nearly three fold.

The Professor has just completed many important enlargements in the manufacturing portion of the work, by which it now has the capacity of producing gas equal to an excess of two-thirds over and above the heaviest demands that can be made upon it. By this arrangement he has placed the city in a very favorable condition with reference to the supply of gas for several years. In the extensions that have been made during the past year and a half, the most improved character of machinery has been constructed for that purpose, so that Prof. Smith leaves the company and its works in an excellent condition.

The Board were loth to lose his valuable services, but the Professor is determined to enlarge the scope and purposes of what he has already accomplished in science.—*Louisville paper.*

The Future of Petroleum.

Although petroleum is not iron, it is so closely connected with it that its ups and downs have a very marked effect upon certain forms of iron and its manufactures. Tubing pipe, steel for tools, engines, boilers, pumps, tank iron, rivets, hoops, all enter largely into producing, refining, and transporting carbon oil; in fact the consumption for this purpose demands the larger part produced of some classes mentioned. This fact gives the iron trade an interest in the future of this product.

Until within the last few weeks, for nearly two years, the state of the crude petroleum business has been one of almost unparalled depression. The heavy stocks on hand at the wells, amounting for most of this time to between four and five million barrels, the enormous daily production, 27,000 barrels a year ago, and the uncertainty as to the limits of the oil field, and of the territory that was being tested, put the market down to a very low figure and kept it there Oil was offered freely, at certain times during this period, at one cent a gallon, and few, if any, buyers at that price. Notwithstanding this, new wells went down, new territory was tested; the "front" was pushed miles towards Pittsburgh, and the future for oil was dubious.

This is now changed; the limits of the producing territory have been clearly defined by a cordon of "dry holes," or gas wells; and in the old territory the "large strokes" are things of the past. Thousand barrel wells exist only in tradition. Production has fallen off—the average daily yield not exceeding 23,000 barrels—while the shipments, mainly for exportation, have for some time past, exceeded the production, reducing the stocks to less than 4,000,000 barrels. The result is that oil is now at a higher figure than at any time during the past ten years.

During the month of January one hundred and forty-five new wells have come in with an average daily production of only fifteen barrels. In the same period one hundred and thirty new rigs have been put up. Though the weather has been favorable to the yield of pumping wells, the average daily production fell off during the month one thousand bbls.

There is another fact favorable to $2 oil. In years past, when the territory was not well-defined, thousands of small operators drilled all over the country, and, as many were fortunate, and their necessities compelled them to sell, they were the means of keeping oil down. Now that this territory is limited, a few producers with large capital have bought up the heaviest producing territory, and are very conservative about sinking wells. It is to their interest to reduce production, and this they do by not increasing the wells. This is wisdom in more than one sense. It keeps up the price and makes the business remunerative, and, beside this, it is a well-known fact that the sinking of new wells in the immediate vicinity of those already producing always reduces the production of the old wells, and unless oil advances to a much higher figure, it is better to get the same amount of oil in twice the time, rather than by sinking a new well to get the same amount of oil in less time. If oil went to $5 or $10 a barrel, this might be different.

In a word, the prospect is that the days of cheap oil are gone. Not but that oil at $2, or even $4, per barrel, is cheap, but we mean the days of 40 and 50 cent oil.—*Iron Age.*

Chemical and Scientific Repertory.

ARTIFICIAL IVORY.—A sort of artificial ivory, which can be carved or moulded, is prepared in Berlin, by mixed phosphate of lime intimately with gutta-percha.

NAPHTHA AS FUEL.—Experiments made with naphtha as fuel for steam engines in the south of Russia are stated to have yeilded such satisfactory results as to induce the Russian Government to order its use in future in all vessels stationed on the Caspian.

THE ENGLISH CHANNEL TUNNEL.—M. Lavalley, president of the French society of Civil Engineers and inventor of the powerful apparatus which contributed to the rapid construction of the Suez Canal, announces that fifteen experimental soundings have been made in the straits of Dover. In none of them were the results unfavorable to the possibility of boring a tunnel to join France and England, and M. Lavalley adds that all the engineers are agreed that the completion of the project is only a question of time and money.

DIAMETER OF CHIMNEY SHAFTS.—The diameter of chimney shaft at the base should not be less than one-tenth of the height. Batter of chimney, 0.3 inches to the foot. Thickness of brickwork, 1 brick from top to 25 feet from ditto; 1½ brick from 25 to 50 feet from the top. If the inside diameter at the top exceeds 4 feet 6 inches, the top should be 1½ brick thick. Fire-brick lining of 4½ inches thick and air space of three inches is generally carried up about one-fifth of the total height of the chimney.

HOW TO TREAT FLESH WOUNDS.—Every person should know how to treat a flesh wound. Every person is liable to be placed in circumstances away from surgical and veterinary aid, where he may have to save his own life, the life of a friend or beast, simply from the exercise of a little common sense. In the first place, close the lips of the wound within the hands and hold them firmly together to check the flow of the blood until several stiches can be taken and a bandage applied. Then bathe the wound for a long time in cold water. "Should it be painful," a correspondent says, "take a pan ful of burning coals and sprinkle upon them common brown sugar, and hold the wounded part in the smoke. In a minute or two the pain will be allayed, and the recovery proceeds rapidly. In my case, a rusty nail had made a bad wound in my foot. The pain and nervous irritation were severe. This was all removed by holding it in smoke fifteen minutes, and I was able to resume reading in comfort." We have often reccommended it to others with like results.

CHROME CEMENT.—This consists of a strong solution of gelatine, to which has been added, for every five parts of gelatine, one of a solution of acid chromate of lime. The mixture becomes insoluble in water under the action of light, in consequence of partial reduction of the chromic acid, and this property is utilized on several occasions in photography. Prof. Schwarz has been experimenting with it as a cement for glass. With a fresh preparation of the solution he covered the surface to be united as evenly as possible, pressed them together, and then tied them together. He then exposed the glass to the sun, and at the end of a few hours the operation had perfectly succeeded. Boiling water has no effect on the oxidized cement, and the fracture could scarcely be recognized. Valuable objects in glass, which would be disfigured with common cement, can be satisfactorily repaired in this manner. It is probable that microscopic object glasses could be better fastened with this than with black asphalte.

NICKELIZING LIGHTNING CONDUCTORS.—Conductors are usually made of an iron rod terminated by a point in platinum or gilt copper. Made in iron the poin

would oxidize rapidly and soon disappear. But in using two metals there is the disadvantage that contact between them is frequently defective and if it were possible, the lightning rod should be made of one homogeneous metal, without welding or solution of continuity. This is realized by M. Saint-Edme, who makes his conductors of a single rod of iron, in one piece from end to end, coated partly or entirely with nickel. The latter metal does not oxidize in damp air, it is a good conductor, and adheres closely to iron. The process of nickelizing is one easily and cheaply effected.

A NEW EMERALD GREEN.—Attention was recently called to the poisonous green colars of wall-papers, and to their continually deleterious effects on those living under their influence. A substitute for paris green and other arsenical colors is said to have been discovered in what is called Guignet's green, a hydrated oxide of chrominum. It is affirmed of it that it is not poisonous, and at all events it is far more harmless than the colors now in ordinary use. It is prepared on a large scale by fusing together, on the hearth of a suitably constructed flame furnace, at a dark red heat, 3 parts boracic acid to 1 part bichromate of potash. The mass swells up, much oxygen gas is envolved, and the substance is finally converted into a beautiful green double salt, a borate of chromium and potash. By repeated washing with boiling water, it is decomposed with hydrated oxide of chromium and a soluble borate of potash. After suitable washing and very fine grinding, this oxide of chromium has a most beautiful shade of color, covers well, stands the air and light, and is only attacked by boiling concentrated acids. On a small scale, this green pigment may be prepared in a porcelain crucible.

Gas-Light Intelligence.

United States.

The directors of the Manhattan Gas Light Company on February 21st, resolved to reduce the price of gas furnished to their consumers, from $2.75 to $2.50 per thousand, after march 1st.

The directors of the New York Ges-Light Company, on February 21st, resolved to reduce the price of gas furnished to their consumers, from $2.75 to $2.50 per thousand, after March 1st.

The directors of the New York Mutual Gas-Light Company on February 22nd, resolved to reduce the price of gas to their consumers, from $2.75 to $2.50 per thousand, after March 1st.

The Gas Light Company on Staten Island has reduced the price of gas from $4.50 a thousand to $3.75, and make a further reduction of 5 per cent. on all bills paid within five days after presentation.—*New York Express.*

The East New York Gas Light Company have offered to reduce the price of gas which they furnish to the Engine houses and the Truant Home, from $4 to $3 per thousand feet.

On and after March 1st, the price of gas furnished by the Metropolitan Gas-Light Company will be reduced from $2.75 to $2.50 per thousand.

General.

A striking and curious experiment, showing the superior weight of carbonic acid gas over air, may be made by projecting the shadow of the gas, as it is poured from its containing vessel upon a screen. The latter should be of white paper, and bright sunlight should fall on the stream of gas, which should be poured from the spout of a pitcher held within ten inches of the screen. The curious result, of a shadow produced by apparently nothing, will be seen, the former resembling descending smoke, quite black at the spout of the vessel, but brightly illuminated whenever the sunlight is concentrated by passing through the gas.—*Coal Trade Journal.*

Transparency of Flame and of the Air.

M. E. Allard has presented to the French Academy several memoirs on the absorption of the light of lighthouse lamps. The first memoir relates to the transparency of flame. From one to six concentric wicks are used in lighthouse lamps, having a diameter of from 3 to 13 cms. A comparison of the luminous intensity of the flames shows that the brightness increases a little less rapidly than the consumption of the oil; comparing the intensity with the dimensions of the flame, it appears that the brightness per square centimeter increases, but that per cubic centimeter diminishes with the size of the flame. This difference may be accounted for by assuming that the flame is not perfectly transparent. These methods were adopted for measuring the absorption, by comparing the light of the edge and side of a flat flame, by reflecting the light a second time through the flame by a mirror, and by viewing the electric light through a a large flame. The results lead to the coefficient of ·80 for the absorption per centimeter in thickness.

After having established the theoretical formulas which give the effective brightness of the flame as a function of its volume and coefficient of absorption, it appears that to satisfy the observations we must assume that the specific brightness increases a little with the diameter. Multiplying then the specific brightness by the volume, it appears that the total quantity of light increases much more rapidly than the weight of oil burned; but as the quantity of light absorbed increases still more rapidly, the light increases a little less rapidly than the oil consumed, as experiment shows.

The second memoir relates to the nocturnal transparency of the atmosphere. Observations are made three times every night by the lighthouse-keepers, as to which of the adjacent lights are visible. Combining the results for several years gives the percentage of nights on which each light is seen. The equation of the range of visibility and a graphical construction serve to show for each light in all cases what degree of transparency of the air is needed to render the light visible. A curve may then be constructed with the transparency of the air and the visibility of the lights as co-ordinates. From this it appears that during half the year the coefficient of transparency per kilometer exceeds ·91 in the Atlantic and ·932 in the Mediterranean. Similar curves give the transparency at different points along the coast, and during the four seasons.

The third memoir treats of the apparent brightness of a light caused by revolving the system of lenses employed with greater or less rapidity. With a certain velocity, a flickering effect is produced, but with an increased speed the light becomes steady with an intensity one or two tenths less than would be obtained by distributing the light uniformly around the horizon.—*Comptes Rendus*, lxxxi, 1096.

The Test of Kerosene Oil.

All the accidents and loss of life that have occurred in this city from kerosene explosions since last May, have been from oils sold as safe, and claimed to range from 110, 130, 150, and over 160 degrees. Not one of these was a safe oil to use, and the tests and facts go to show that they were not properly made. The tests, in every case, show that they commenced to flash at a very low temperature, and flashed at every 5 and 10 degrees, until the naphtha was sufficiently evaporated. A very little naphtha in a good oil will render it dangerous. In oil that only flashes at 112 or 130 degrees, the addition of one per cent. of naphtha will cause it to flash at 103 degrees, and two per cent. of naphtha at 92 degrees, and so on to 40, for the simple reason that any oil which boils at a low temperature will give off an inflammable vapor at a still lower temperature, which vapor will be driven out when it is mixed with any other oil.

One serious trouble is that the test recognized by law is not safe, and it is because the law recognizes a low test, say 110 degrees, as safe that manufacturers will make it. Dealers who care nothing for the lives of others, will adulterate it with cheap benzine or naphtha because they can make a few cents extra. and consumers buy it because it is cheap. The remedy of this whole matter lies with the consumers; let them demand a high test. and buy only of responsible makers and dealers.

The insurance companies and Board of Underwriters can render great and important service, by insuring no building, stock, or lives where a low grade of oil is used, sold, or kept. They have already learned a great deal by experience, and to their own serious loss, when they insured various grades of petroleum without making a distinction between the heavy and light, or the more safe and especially dangerous oils. —*Manufacturer and Builder.*

Lighting of London.

From returns made in reply to government inquiries, the following remarkable particulars have been gained: The total amount of capital invested in the eight metropolitan gas companies is £10,000,000. The gross expenditures in 1874 amounted to £620,000, of which 75 per cent., or £470,000, was paid for new buildings and machinery; 20 per cent., or £122,000 for new and additional mains; and the remaining 5 per cent., or £27,000, for new and additional meters, fresh land and law charges. In mid-winter some of the largest gas works have to send as much as 17,000,000 cubic feet of gas in the course of the night. Some of the gasometers are now 140 feet in diameter and 70 feet high, or as large as a good-sized amphitheater, and have a capacity of upwards of a million cubic feet. The gross quantity of gas supplied to the entire metropolis now is as much as 14,000,000,000 cubic feet per annum, which is at the rate of 38,000,000 feet per diem. To produce this enormous volume of gas about 1,500,000 tons of coal require to be carbonized or "cooked" in the course of the year. Each ton of Newcastle coal produces on an average 10,000 cubic feet of gas and 1 cwt. of coal about 2½ bushels of coke. The cost of the coal alone for lighting London with gas amounts to £1,750,000 per annum. The value of the "residual products," such as coke, the breeze, the tar and the ammonia liquor, arising from the destructive distillation of the 1,500,000 tons of coal, is as much as £700,000 per annum. The "gas rental" of the entire metropolis is just upon £3,000,000 sterling, including rather more than £250,000 paid for public lamps, so that not quite £2,750,000 are paid for the gas supplied "per meter." The total length of the streets of London, according to act of parliament, is 2500 miles. The total length of the gas mains throughout London is probably 5000 miles. The number of street lamps throughout London is 54,000 odd, or one lamp to every 80 yards of roadway. The gross cost of erecting the 54,000 street lamps could not have been less than £135,000. The street lamps consume just upon 1,000,000,000 cubic feet of gas per annum.—*Iron Age.*

Diphtheria.

About a year ago, Dr. Stephen Smith, of the New York Health department, published some useful suggestions relative to diphtheria which are well worth remembering. Under the heading of precautions, in addition to the removing of sources of sewer gas escape as mentioned above, he advises the removal of every kind of filth from around the house, the cleaning and whitewashing of dirty walls, and the disinfection of cellars and ventilation of all apartments, especially those which have been occupied by people suffering with disease. It is well, in such rooms, not only to limewash the ceilings but to paint the woodwork, boil or subject to a high degree of heat every article that can be so treated, and expose the room and its contents to currents of fresh air for at least a week before reoccupation. Children that are well should not be allowed to kiss others affected with

sore throat, or sleep in the same room, or use toys or other articles previously handled by the sick. It is safer to isolate ill ones from all the family, except, of course, the necessary attendants. The air in the sick room should be changed at least hourly, and all discharges from the mouth and nose should be received into vessels containing disinfectants, such as solutions of carbolic acid or sulphate of zinc, or upon cloths which are to be immediately burnt or else boiled or soaked in disinfecting fluid.

Diphtheria, like many other serious maladies, is not difficult to check if attended to in time; but it frequently baffles the highest skill if allowed to run. Its distinctive feature is the formation of a false membrane in the throat, which shows itself in grayish brown patches. Sometimes the whole membrane forms suddenly; but as a rule, the patches first appear accompanied by fever and prostration. The first symptoms of the disease, sore throat and abnormal heat, are too often considered as premonitory of a simple cold; but there is no necessity of such error if parents will carefully examine the throats of their children as soon as soreness is complained of. The patches can almost always be well recognized, and a competent physician should be instantly summoned. Homemade remedies and gargles should not be depended upon; and the only treatment worth practising before the doctor arrives is to administer pounded ice, the use of which was found very effectual during the ravages of the disease in the Oneida community in this State. The prevailing dampness peculiar to the winter months may lead to increased numbers of cases of the malady. It is well therefore to keep in mind that there are but three safeguards: first, cut off the foul air; second, watch sore throats in the family; and thirdly, summon the doctor immediately.—*Scientific American.*

Steel Making Among the Hindoos.

Dr. A. Hunter, a contributor to the *Art Journal* says: The fuel employed by the steel making Hindoos is hard, dense, charcoal, made of the wood of the babool, or some species of the acacia. When the steel is melted the heat is kept up steadily for an hour or more, and the furnace mouths are closed with clay to exclude cold air, and to allow the metal to cool slowly. Next day the crucibles, when cold, are broken, and the lumps of steel removed and sorted into the different sizes for knives or small tools, daggers, spear heads or saw blades. The lumps of steel are called oollies, and they find a ready sale in most of the markets of India, at 1s. per pound.

Till very lately there was a considerable export trade of Indian wootz steel to Upper India, Persia and Damascus. One of the peculiarities of this steel is its malleability and ductility, combined with great toughness: it requires to be worked, however, in a peculiar way, as it is easily spoilt if the heat be too great. The general rule is not to urge it beyond a dull cherry red, and not to keep it too long in the fire, as it becomes brittle and liable to crack if made white hot. Very heavy hammers are used in proportion to the size of the work, and the quicker the hammering the better are the tools or weapons. If the heat has been too great the steel is spoiled, and it cannot again be restored to its pristine malleability. The reason for this is, that a portion of the carbon has been burned away, and the metal has been reduced to a hard brittle iron, which opens into cracks and will not weld. To remedy this defect it is beaten out with soft malleable iron in bars, embedded in fresh charcoal, and covered with pieces of hoofs and horns, or old leather, and thus partially converted again into a soft steel.—*Scientific Press.*

Invariable Weights.—A question has been raised as to variability of platinum weights in process of time. The Warden of the standards shows, in his recent report, that the weight of the English platinum kilogram of the Standards Department was found in 1875 to be practically unchanged since it was weighed with the greatest care and accuracy, in 1846, and that its utmost possible loss of weight in that period could not have exceeded three parts out of 10,000,000. But though the platinum standard weights have thus been found unaltered by atmospheric influences, the slight changes observed in a few exceptional cases being attributable to improper preparation of the metal, yet pure platinum is too soft a meterial to stand the friction of much use without losing some of its weight. This defect, it is found, may be remedied by combining with the platinum about 10 per cent. of iridium. An alloyed metal is thus produced as hard as steel, such as has been adopted for the new international standard kilograms by the Metric Commission at Paris.

Waste of Water.—Mr. Gale, the engineer to the Glasgow Water Committee, recently read a paper detailing the results of some experiments he had made in five districts of the city discovering and reducing the waste of water, in the course of which he stated that he had found the defective fittings consisted of three classes—viz, burst service pipes, fittings out of repair, and fittings wanting in conformity with the rules. The result of attending to these defects had been a waste reduction of 25 gallons per head, or 127,375 gallons per day over the population using water in the districts. The committee authorized further experiments to be made.

PRICES OF FOREIGN AND DOMESTIC GAS COALS.

[Reported Expressly for this Journal.]

MARCH 2, 1876.

DELIVERED IN NEW YORK.

English Cannel.

Ince Hall	$17 00	@	18 00
Kirkless Hall	16 50	@	17 00

English Caking Coals.

Newcastle Gas	$5 50	@	00 00
Liverpool caking	11 50	@	12 00

British Province Coals.

Pictou			2 00
Block House—At Mines, $1.87, Gold			2 00
Caledonia—At Mines, $1.50, Gold			0 00
Little Glace Bay—At Mines, $1.75, Gold			0 00
Lingan—At Mines, $1.75, Gold			0 00
Sydney—Old Mine			3 00
" Reserve, $1.75, Gold Mine			0 00
" International			— —

Duty, 15 cents per ton, gold. Freight to New York $2 00 currency. Cost of above coals delivered in New York, $4 75 @ $5 00, currency.)

Pennsylvania Coals.

Penn Gas Coal—At Amboy	$5 60	@	0 00
Westmoreland—At Amboy	5 60	@	0 00
(In New York both the above coals $6 00)			
Shafton	6 50	@	0 00
Youghiogheny	6 00	@	0 00
Waverly	6 00	@	0 00

West Virginia Coals.

Murphy Run	$6 50	@	0 00
Despard	6 50	@	0 00
West Fairmont	6 50	@	0 00
American Gas Coal	7 40	@	0 00
Fairmont	6 50	@	0 00
Newburgh Orrel	6 50	@	0 00
Pinnickinick	6 50	@	0 00
Cloverhill of Virginia	6 00	@	6 50
McKenzie Compound Mixture			— —

American Cannel Coals.

Peytona of West Virginia	$12 50	@	00 00
Darlington of Pennsylvania			— —
Cannelton Cannel			11 00
Red Bank—at Philadelphia			6 50
" —at South Amboy			7 25

Asphalts.

Albertite of New Brunswick	$21 00	@	— 00
Trinidad Bitumen	— —	@	14 00

The Penn Gas Coal Company have contracted with the Pittsburgh Gas-Light Co. for their entire supply for the ensuing year from their Youghiogheny mines.

Within the last week contracts have been made by some of the companies in New York for about 200,000 tons of Penn, Westmoreland, Waverly, Youghiogheny, and the West Virginia caking coals—at $6 00 per ton a reduction of 50 cents from last years' prices.

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

24 PINE STREET, NEW YORK CITY.

MARCH 2, 1876.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	Par.	Bid.	Asked
Harlem	$1,850,000	50	130	133
Manhattan	4,000,000	50	270	—
Metropolitan	2,500,000	100	160	161
" Scrip	$1,000,000	..	104	105
" Bonds	500,000			
Mutual	5,000,000	100	109	110
New York	4,000,000	100	150	153
Central, Westchester	466,000	50	100	105

Gas Co.'s of Brooklyn.

Brooklyn	2,000,000	25	—	200
Citizens	1,200,000	20	100	105
" Scrip		...	100	101
Peoples	1,000,000	10	70	75
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	84	85
Metropolitan	1,000,000	100	70	80
Nassau	1,000,000	25	100	103
" Ctfs	700,000		95	98
Williamsburgh	1,000,000	50	—	143
" Scrip		...	100	102

Out of Town Gas Companies.

Buffalo Mutual, N. Y	750,000	100	50	50
Baltimore, Md	2,000,000	100	175	...
Brockport, N. Y	25,000	...	...	85
Citizens, Newark	500,000	...	70	75
Derby of Conn	160,000	100	...	80
East Boston, Mass		25	112	115
Hannibal, Mo	100,000	100	58	60
Hartford, Conn	700,000	25	41	43
Hempstead, L	40,000	100	...	100
Jersey City	386,000	...	160	...
Jamaica, L. I	25,000	100	...	100
Jacksonville, Ill	120,000	50	82	...
Lewistown, Maine	400,000	100	...	75
Lima, Ohio	60,000	100	10	...
Laclede, Mo			110¼	123
Peoples, Jersey City		...	125	135
Peoples of Albany	1,000,000	100	31	40
Peoples of Baltimore		25	96¼	...
Rochester, N. Y		100	50	...
Richmond Co., S. I.	300,000	...	100	105
Fort Wayne, Ind		100	...	105
Woonsocket, R. I	150,000	100	100	...
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150,000	40	112½	

The following stocks were sold at auction—

48 shares Peoples', of Baltimore, @ 96¼; 24 shares of Baltimore, Md., @ 175; 120 shares Laclede, St. Louis, Mo., @ 110¼; 25 shares Buffalo Mutual, @ 50; 20 shares Manhattan, @ 270.

TO GAS COMPANIES.

JACOBI'S IMPROVED APPARATUS FOR DRYING COAL

IS SIMPLE, INEXPENSIVE AND EFFECTIVE AND A COMPLETE SUBSTITUTE FOR THE STORAGE SHEDS NOW USED.

Address for particulars, JACOBI & WARD.
217 Scott Street, Baltimore, Md., and
401-2t 167 West 49th Street, New York.

THE ATTENTION OF **MANUFACTURERS OF COAL GAS** is called to a new Process for Making Gas from the Hydrocarbons distilled from Bituminous Coal at a low temperature and Water Gas, so combined as to utilize the entire luminiferous capacity of the coal, thus avoiding the destructive action of Incandescent Coke upon the Hydrocarbons, and insuring the greatest possible economy and convenience in manufacture.

For particulars inquire of Dr. M. W. KIDDER, 47 India Street, Boston. 401-12t

Gas Works for Sale

In a thriving, growing little city of seven thousand inhabitants, in North Western Ohio. Price, $75,000. Good terms as to payment. No letters answered unless reference is given. Enquire of A. M. CALLENDER & CO.,

401 Office of AMERICAN GAS-LIGHT JOURNAL.

THE LOWE GAS PROCESS.

S. A. STEVENS & CO.,

SOLE AGENTS.

ROOM 87, ASTOR HOUSE.

P. O. Box 1110, NEW YORK.

AND

400 430 WALNUT STREET, PHILADELPHIA.

TO GAS-LIGHT COMPANIES,

A **PRACTICAL GAS MAN** WISHES TO PURCHASE or Lease

A Small Gas Works,

making from 3,000 to 10,000 cubic feet of Gas per day. Address, with full particulars, HENRY PORTER,

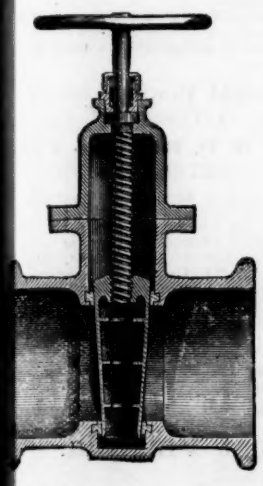
409-2t Sup't Gas Works, Cold Spring, N. Y.

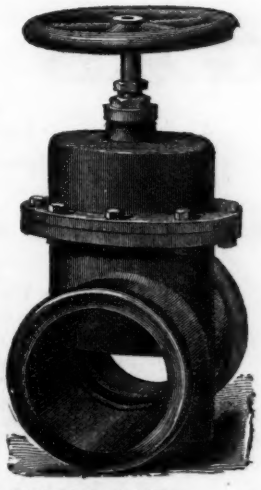
CHAPMAN VALVE MANUFACTURING CO.

MANUFACTURERS OF

CHAPMAN GAS VALVES.

Office and Sales Room 75 and 77 Kilby Street, Boston.





These Valves have been in use for several years, and are pronounced by all who have used them to be

The Best Gas Valves Ever Made.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

There is no LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHT and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

We refer to the following named Gas-Light Companies among the many that have used these Valves:

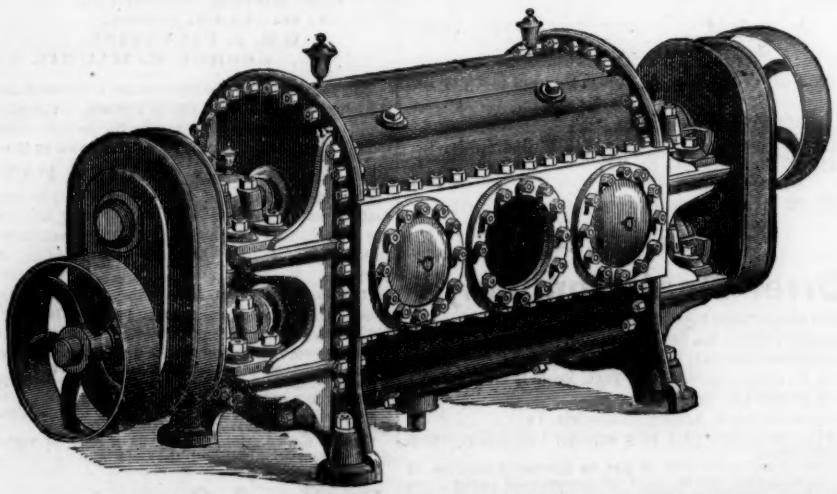
BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CAMBRIDGE GAS-LIGHT COMPANY, CAMBRIDGE, MASS.
NEWTON & WATERTOWN GAS-LIGHT CO., WATERTOWN, MASS.
LAWRENCE GAS-LIGHT COMPANY, LAWRENCE, MASS.
PEOPLES GAS-LIGHT COMPANY, BROOKLYN, N. Y.
CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
SOUTH BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
LYNN GAS-LIGHT COMPANY, LYNN, MASS.
FITCHBURG GAS-LIGHT COMPANY, FITCHBURG, MASS.
CITIZENS GAS-LIGHT COMPANY, NEWARK, N. J.
WILLIAMSBURGH GAS-LIGHT CO., WIRLIAMSBURGH, N. Y.

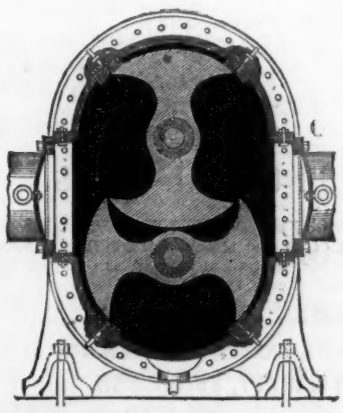
GAS AND WATER VALVES ¾ INCH TO 36 INCHES DIAMETER.

STEAM VALVES ½ INCH TO 12 INCHES DIAMETER.

357-1f

PATENT IMPROVED GAS EXHAUSTER.





P. H. & F. M. ROOTS, PATENTEES AND MANUFACTURERS, CONNERSVILLE, IND.
S. S. TOWNSEND, GENERAL AGENT, 31 LIBERTY STREET, NEW YORK.

The following are some of the advantages we claim for this Exhauster over all others:

FIRST.—It is simpler in its mechanical construction than any other Exhauster in use.

SECOND.—The internal parts consist of only two revolvers, each cast entire in one piece, without a single screw, bolt, nut, washer, key or other part to get loose on the inside and stop or break the machine. The internal operating parts, therefore, can not get out order and hence require no care or attention.

THIRD.—Every part of the machine requiring care or attention, as the journals, gearing, etc., is external, easily observed and attended to. All changes, adjustments, and repairs are made from the outside. The journal bearings, if necessary, can be renewed in a few minutes.

FOURTH.—The internal operating parts are practically gas-tight, but are not in actual contact, hence there is no internal friction or wear. The machine is therefore operated with less power than any other.

FIFTH.—They are built in the most complete and substantial manner, with steel shafts and improved journal bearings, and their durability is almost without limit.

We build them of any required capacity, large or small, adapted to any kind of works or place.

Send for Illustrated Catalogue, giving all particulars as to capacity, speed, power required, dimensions, and price of each size and references to parties using them.

P. H. & F. M. ROOTS.

GAS COALS.

THE
PENN GAS COAL COMPANY

OFFER THEIR

COAL, CAREFULLY SCREENED,

AND PREPARED FOR

GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

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Greenwich Wharves, Delaware River.
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OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West Virginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

cknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 ubic feet of GAS of 64·54 CANDLE POWER; COKE 32 bushels, of good quality.

CANNELTON CAKING COAL.

Volatile Matter.	Coke.	Per cent. of Ash in		Sulphur in			Specif. Gravity.	
		Coal.	Coke.	Coke.	Oötl.	Volatile Matter.	Coal.	Gas.
35.1	64.9	2	6	.82	1.48	.66	1.289	.476

MAXIMUM YIELD, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb.—gave 16 14-100 Candle-Power.

COKE, of very fine quality—1453 pounds produced from one ton of coal.

SALES AGENTS { **J. TATNALL LEA**, Treasurer, P. O. Box 1747 Philadelphia. **PERKINS & JOB**, 27 South Street, N. Y.; 91 State Street, Boston. **H. W. BENEDICT & SON**, New Haven.

SCOTCH CANNEL COALS.

THE SUBSCRIBER IS PREPARED TO CONTRACT FOR the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

JAMES McKELVIE,

CANNEL COAL MERCHANT,

HAYMARKET, EDINBURGH.

ESTABLISHED 1840. 357-1y

WREN'S GAS WORKS.

W. C. WREN,

Corner of Jay and Water Streets,

BROOKLYN. N. Y.

HAVING GRANTED THE USE OF ONE OF my Patents to the Gas-Light Company of America, and settled my claim against them, I inform the profession that I continue to erect the Works known as

Wren's Gas Works,

and sell Licenses to use my Patents for making Gas from Petroleum.

Gentlemen of the profession:—As your consumers demand a better light, and as that demand has been in many cases sought in vain to be met by using different abortive imitations of my various processes, would it not be well to make success sure by trying the plan of the inventor.

You can enrich your Coal Gas to any desired standard, by using my process, in the simplest manner, and much cheaper than by *any other* method. Address as above. 397

THE NEWBURGH

Orrel Coal Company,

Mines at Newburg, Preston County, W. Va.

Company's Office, No. 52 S. Gay Street, Baltimore, Md.

C. OLIVER O'DONNELL, Pres't. CHAS. MACKALL, Sec'y.

CHAS. W. HAYS, Agent in New York, Room 7, Trinity Building, 111 Broadway.

SINCLAIR & AGNEW, Agents, Alexandria, Va.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

994-1y n

THE DESPARD COAL COMPANY

OFFER THEIR SUPERIOR

DESPARD COAL

To Gas Light Companies throughout the country.

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BANGS & HORTON, No. 31 Duane street, Boston.
Mines in Harrison County, West Virginia.
Wharves Locust Point, Company's Office, 15 German St., } Baltimore.

Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine.

*** Reference to them is requested. 204-1y

NEW YORK AND CLEVELAND

GAS COAL COM'Y

Of Pittsburgh, Pa.

MINERS AND SHIPPERS OF

YOUGHIOGHENY GAS COAL.

This Company is prepared to furnish any amount of their justly celebrated, and acknowledged superior GAS COAL, to any point reached by railroad or navigation, on most favorable terms.

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PITTSBURGH, PA.

Branch Office—C. & P. RR. Coal Pier,
CLEVELAND, OHIO.

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THOMAS AXWORTHY, Agent at Cleveland, Ohio.
W. H. WATERBURY & CO., General Sales Agents,
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CANNEL COAL

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I. B. BRICE, Vice-President.
A. H. ALLEN, Secretary.
WM. J. VALENTINE, Treasurer.
GEORGE W. HARRIS, Engineer.

This Company is the owner of the GWYNNE-HARRIS, or AMERICAN HYDROCARBON process, for making Gas for Lighting or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

GWYNNE AND HARRIS PATENTS.

This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest improvement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products."

Further information, and terms of sale of rights will be given, upon application to the Company 348-1y

Portland Cement,
Roman Cement,
Keene's White Cement,

NUMBERS 1 AND 2.

From best London Manufacturers.

FOR SALE BY

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76 South Street, New York,

Corner Maiden Lane. 344-1y

☞ Remit 10 cents postage for "Practical Treatise on Cement."

B. E. CHOLLAR,
GAS ENGINEER,

914 OLIVE STREET, ST. LOUIS, MO.

385-

THE WAVERLY COAL AND COKE CO.

Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

from their Colliery at Smith's Mills, on the Youghiogheny River, thirty-seven and a half miles southerly of Pittsburgh. This Coal has the preference in Pittsburgh over all other YOUGHIOGHENY COAL for GAS PURPOSES.

The facilities of the WAVERLY COMPANY are unsurpassed by those of any other Company on the Youghiogheny.

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27 South Street, New York.
91 State Street, Boston.

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1852 TROY, N. Y., 1876.

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OF THE GENUINE

SABBATON

Coke Shovels,

WITH EITHER

Long or D Handles.

WELL KNOWN AMONG

The Principal Gas Companies throughout the Country.

PRICES REDUCED, and Shovels delivered in New York per lots of one dozen or more.

Orders solicited. 399-6

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CLAY RETORTS.

JOSEPH CLIFF & SONS.

WORTLEY, LEEDS,

ENGLAND,

Are open to arrange with a respectable and responsible firm for the sale of their

Patent Clay Gas Retorts,

For the United States and Canada.

These goods are very superior to any yet made, and are specially suited for export, being so strong and well made. J. C. & Son would deliver at New York or other port—the rm of Agents would then take all expenses and responsi- They can be delivered at such prices as will assure a very large trade. References given and required. 2t

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Manufacturers of

CHANDELIERS !

And Every Description of

GAS FIXTURES,

Also Manufacturers of

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GREENE AND ESSEX S TREETS,

JERSEY CITY, N. J.

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Fire Bricks, Etc. Etc.

Ground Clay, Fire Brick and Fire Sand in Barrels,

ALWAYS ON HAND.

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ALSO,

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OF EVERY DESCRIPTION,

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Gas Engineers,

AND PARTIES ENGAGED IN THE BUILDING OF

GAS WORKS,

who desire information regarding PETROLEUM GAS, either for use pure or for enriching. are requested to address. stating particulars.

J. D. PATTON,
363-unl Treverton, Northumberland Co. Pa.

FOR SALE,

200 Tons
CANNEL CHIPS.

Address **H. E. HOY,**
34 New Street, N. Y.

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American Meter Co.—West 22nd st., N. Y., Arch and 22d st., Phil., 548 Washington st., Boston.... 1
Cast Iron Gas and Water Pipe—S. Decatur Smith, York and Moyer streets, Phila., Pa.
Cast Iron Gas and Water Pipes—R. D. Wood & Co., Philadelphia Pa. 16
Cast Iron Gas and Water Pipe—Jno. McNeal & Sons, Burlington, N. J.
Franklin Foundry and Pipe Works—Jas. Marshall & Co., 23 Nineteenth street, Pittsburgh, Pa.
Gas Valves (Chapman) 75 and 77 Kilby st., Boston, Mass.
Gas-Burners—C. Gefrorer, 248 North 9th st., Phila., Pa.
Gas Purification—St. John and Cartwright
Gas Meters, etc.—Harris, Griffin & Co., 12th and Brown streets, Phila., Pa. 10
Gas Meters, etc.—Wm. W. Goodwin & Company, 1012 Filbert street, Phila, Pa. 17
Gas Meter Manufacturers—Harris & Bro., 1117 Cherry st., Philadelphia, Pa. 11
Gas Fixtures, Etc.—Mitchell, Vance & Co., 597 Broadway.. 7
Clay Gas Resorts, etc., etc.—J. H. Gautier & Co., cor Greene and Essex streets, Jersey City, N. J.
Gasholders, Etc.—Deily & Fowler, 39 Laurel st., Phila., Pa..
Gas Screen—James P. Mahon, Boston, Mass.
Lime Hurdles.—Manhattan Lime Hurdle Co.; Geo. W. Day, Treas., No. 3 Railroad Square, Haverhill, Mass.
Lava Tips and Scotch Tips—Charles H. Meyer & Co., 227 Chestnut street, Phil. Pa.
National Tube Works Co., 78 William St., N. Y.
Patent Conically Slotted Wood Trays—John L. Cheesman, 147 and 149 Avenue C., N. Y.
Patent Gas Exhauster—Smith & Sayre, 95 Liberty stfreet.
Pelouze & Audouin Condenser—Jas. R. Smedberg, Sole Agent for U. S. San Francisco, Cal.; Henry Cartwright, 2107 Green street, Phil. Pa.
Petroleum Gas—J. D. Patton, Treverton, Pa.
Patent Gas Exhauster—S. S. Townsend, Agt., 31 Liberty street, N. Y.

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Cannelton Coal Co. of West Virginia—J. Tatnall Lea, 325. Chestnut street, Phila, Pa.
Despard Coal Co.—Parmelee & Bros., Agents, 32 Pine st., New York. 7
Gas Coals—Perkins & Job, 27 South st., N. Y. 7
New York and Cleveland Gas Coal Company—384 Penn Avenue, Pittsburgh, Pa. 6
Penn Gas Coal Co.—11 Merchants' Exchange, Phil. and 90 Wall street, N. Y. 6
Peytona Cannel Coal—S. E. Low, 58 Broadway, N. Y. 5
The Newburg Orrel Coal Co.—Chas. W. Hays, Agent in New York, Trinity Building, 111 B'way, Room 7. 6
Tyrconnell Gas Coal—52 S. Gay Street, Baltimore, Md. 6
Westmoreland Coal Co.—230 South 3rd Street, Phil. Pa. 7
Youghegheny Coal—Perkins & Job, 27 South St. N. Y. 7

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Atlantic Dock Iron Works—John P. Kennedy, Office 98 Liberty street, N. Y., P. O. Box 2348.
Cast-Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md.
Continental Works—T. F. Rowland, Greenpoint.
Camden Iron Works, Camden, N. J.—Jesse W. Starr & Son.
Gloucester Iron Works—J. P. Michellon, Sec., 6 North 7th street, Phila., Pa. 4
Mill Street Foundry.—Geo. Stacey & Co., Cincinnati, O. 5
National Foundry and Pipe Works—Wm. Smith, Carroll, Pike, Smallman & Wilkins streets, Pittsburg, Pa.
Oregon Iron Foundry—Herring & Floyd, 740 Greenwich street, N. Y. 10
Pascal Iron Works—Morris, Tasker & Co., Philadelphia. 12
Providence Steam and Gas Pipe Co., Providence, R. I.—H. A. Branch, Agent. 3

WATER METERS, PUMPS, ETC.

Cast Iron Pipes for Water and Gas—Riley A. Brick, 112 Leonard street, N. Y. 10
Valves for Water, Steam and Gas—Ludlow Valve Man'g Co., 940River street, Troy, N. Y. 6

CLAY RETORT WORKS.

B. Kreischer & Son, Clay Retorts, etc., 58 Goerck st., N. Y. 8
Cheltenham Fire Brick and Clay Retort Works—Evens & Howard, 916 Market street, St. Louis, Mo. 8
Manhattan Clay Retort Works, 15th st., near Av. C, N. Y. 8
Philadelphia Fire Brick Works, Vine and 23d sts., Phila. 9

LAMPS, STOVES, PETROLEUM, ETC.

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Patent Lamp Post—J. W. Graham, Chillicothe, Ohio, or A. M. Callender, office of this Journal.

MISCELLANEOUS.

Analysis and Testing of Gas Coals—Prof. Henry Wurtz, 12 Hudson Torrace, Hoboken, N. J. 10
Architect and General Gas Engineer—William Farmer, 111 Broadway Room 95, N. Y.
Brass Cocks, Plumbers' Materials, etc., etc.—McNab & Harlin Manufacturing Co., 56 John st., N. Y. 7
Cements—S. L. Merchant & Company, 76 South st., N. Y.
Contractors for Gas Works, Etc.—Murray & Baker, Fort Wayne, Ind. 9
Fodell's System of Bookeeping—A. M. Callender & Co., 42 Pine st., New York. 1
Gas Engineer—B. E. Chollar, 914 Olive St., St. Louis, Mo.
Gas-Light Company of America, 63 and 64 Drexel Building, New York. 2
Kidd's Gas Consumers Guide—A. M. Callender & Co., 42 Pine Street, N. Y.
Massachusetts Institute of Technology—Samuel Kneeland Boston, Mass.
National Coal Gas Company—H. P. Allen, 4 Warren street New York. 6
School of Mines, Columbia College, East 49th st. 9
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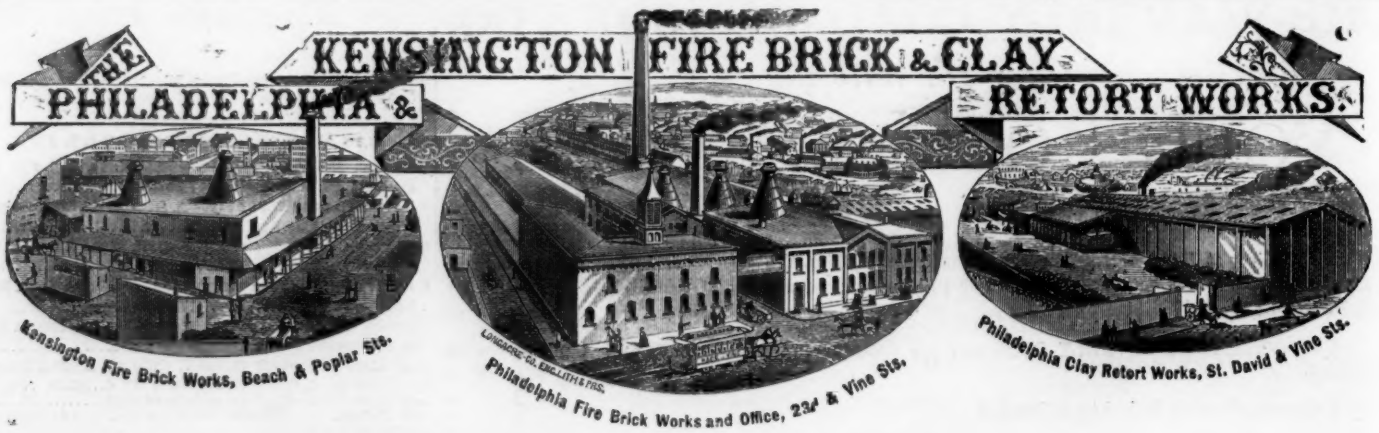
Scientific and Practical Chemist and Geologist—Profetsor Henry Wurtz, 12 Hudson Terrace, N. J. 7
Screening Shovels—G. W. Dean, 1258 Broadway, N Y.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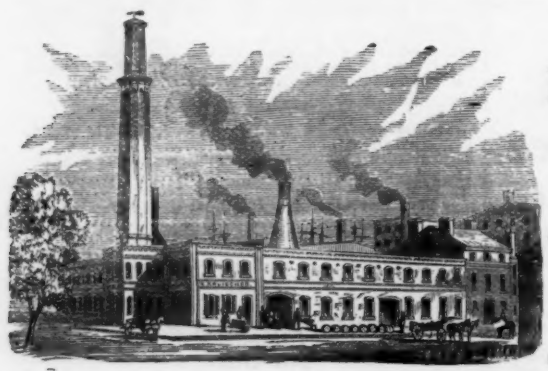

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Having withdrawn from the firm of R. D. WOOD & Co., the practical management of which we have had since the organization of that firm until June 1871, we have now completed our Works for the manufacture of CAST IRON PIPE and Castings generally.

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Our experience in the manufacture of Pipe for a great many years, has enabled us in rebuilding to practically apply Machinery and Fixtures of the very best character, to insure *good work.*

We are now prepared to contract for this class of Castings under the most favorable terms.

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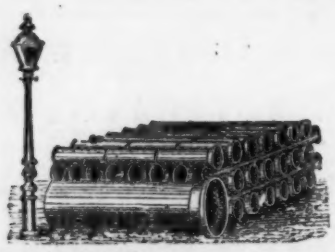

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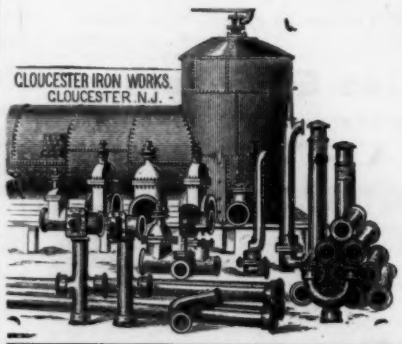

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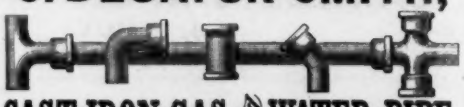

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Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

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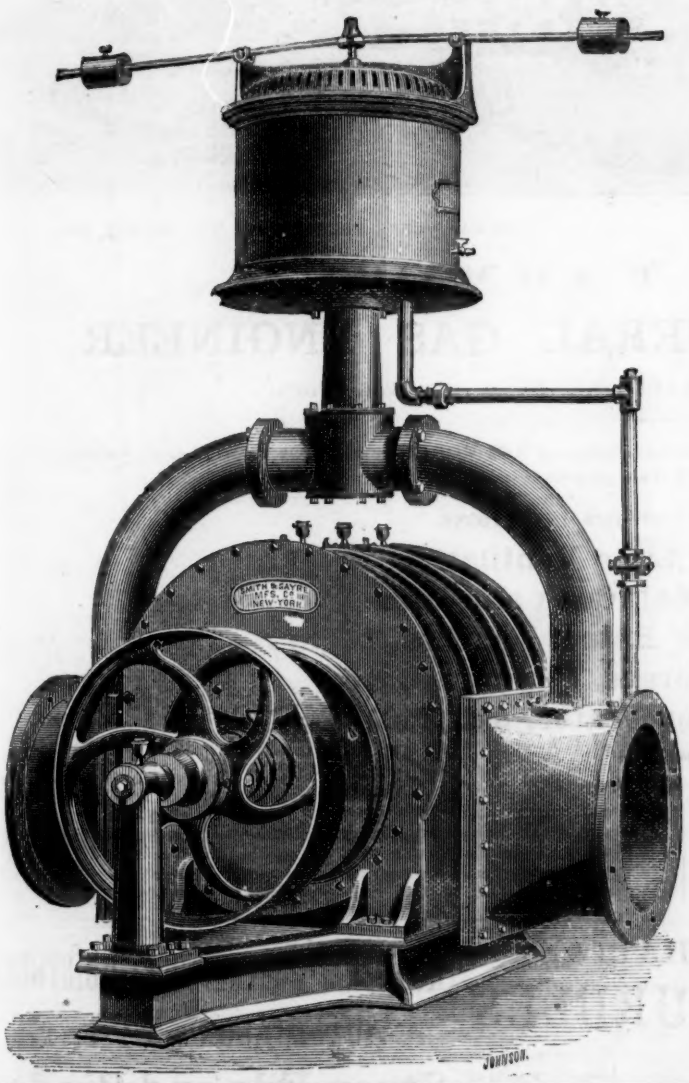

They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas, and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-jo ints, is compact, durable, cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

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The Blower is a Force Blast machine, durably built, and can be driven with one-third the power required to drive the ordinary fan

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THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

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AND
Wren and Barker Patents,

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An examination of the merits of these inventions as demonstrated by practical experience in a large number of Gas Works employing them, will not fail to convince the intelligent Gas Manufacturer of the great advantages derived from their use.

Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary quality of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light to their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these processes in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit, Mich., whose works more nearly conform in all details of construction to the original plans of the inventors than those of other Companies.

For Correspondence, etc., address to office as above.

CHARLES F. DEAN, Secretary.

1842. DEILY & FOWLER. 1876.

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SINGLE AND TELESCOPIC—WITH CAST OR WROUGHT IRON GUIDE FRAMES.

We are prepared to furnish Holders, Wrought Iron Roof Frames, Bench Castings, Condensers, Scrubbers, Purifiers, Drips, Bends, Tees, and all other Iron Work connected with Gas Works. Previous to 1868 our Mr. D. built *nine Gas Works* and *fifty-four Holders*. Since that date we have built *three Gas Works* and *forty-six Holders*. We *superintend in person* the erection of all our work, and would refer to the Gas Companies at the following places, where we have built Holders, since 1868:

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Youngstown, O
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Barnesville, O.
Franklin, Ind
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Jefferson City, N. O , La.
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Kalamazoo, Mich.
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Meriden Conn-

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Continental Works,

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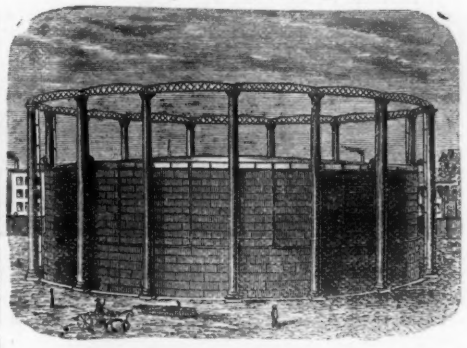

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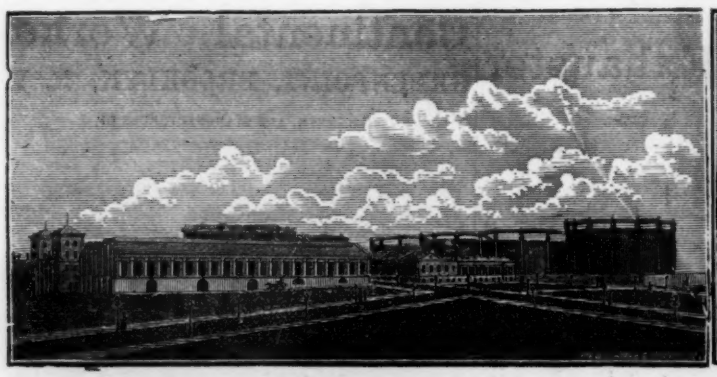

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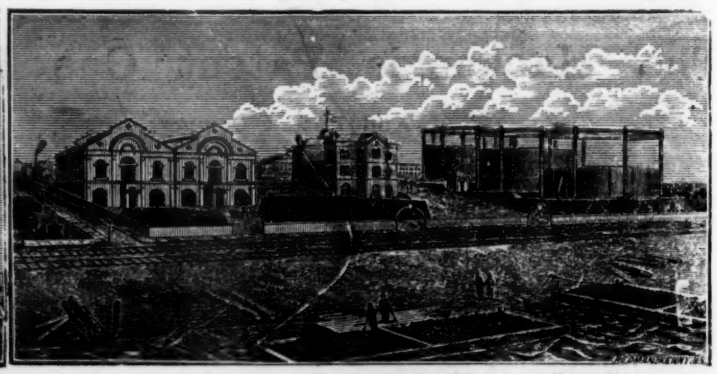

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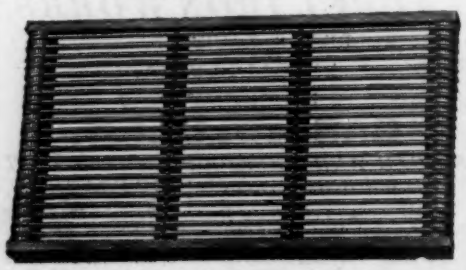

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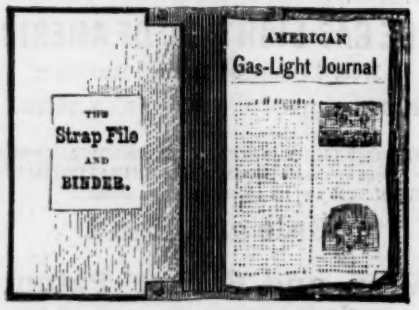

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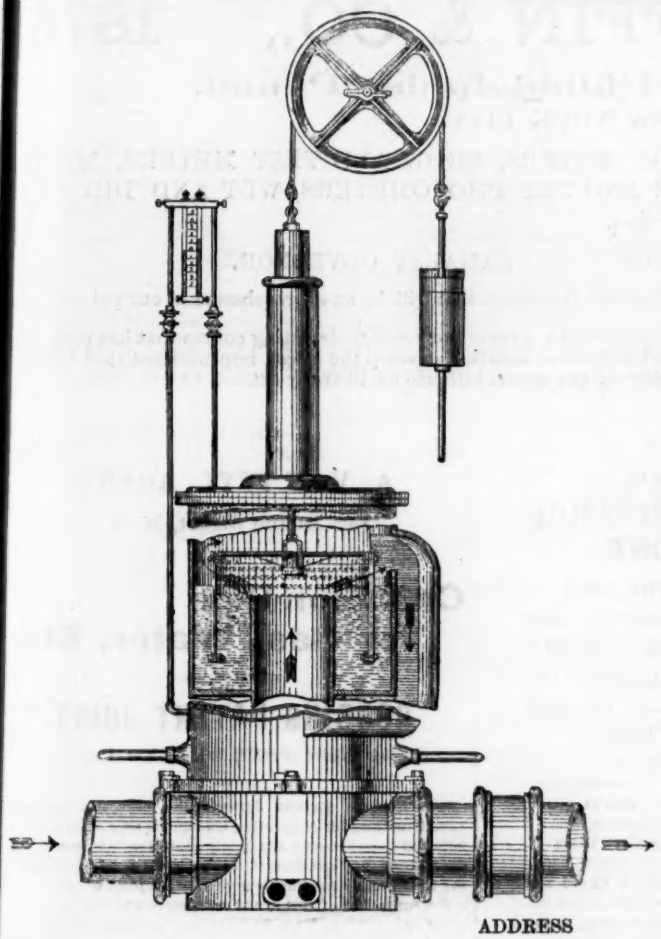

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WASHERS.—Cataract and Single and Multitubular Spray Washers.

CONDENSERS.—Single and Multitubular Air and Water Condensers.

PURIFIERS.—For Purifying from 1,000 to 2,000,000 cubic feet capacity daily, with either wet or dry Lime, or Oxide of Iron, and with either Ash Rivetted or Wrought or Cast Iron Lime Sieves.

CARRIAGES.—Movable Lifting Carriages for Purifiers, arranged either for Floor or Overhead use.

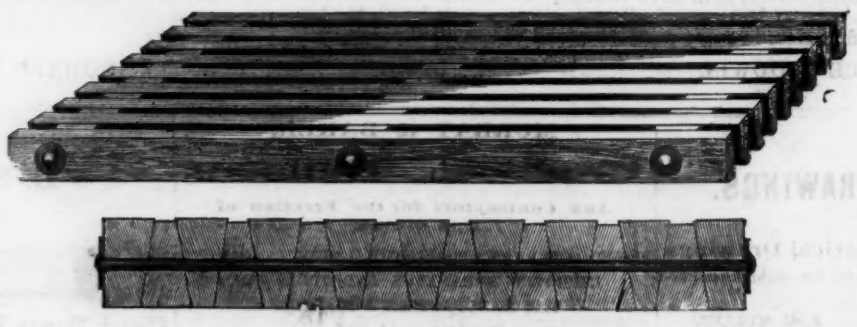
METERS.—Square and Round Meters of any capacity.

GAS HOLDERS.—Single Lift and Telescopic Gasholders, with Cast or Wrought Iron Suspension Frames.

GAS GOVERNORS.—Station Governors, with Regulating and Indicating Columns for Inlet and Outlet Pipes, also Dry Governors with Flexible Diaphragms for Underground Pipes.

STOP VALVES.—Double Faced Stop Valves for Gas or Water, from three inches to forty-eight inches diameter. These Valves are proved on both sides, with a heavy Water Pressure, Flange and Bell Pipes, Fittings and Drips of all descriptions. Steam Boilers and Hot Water Apparatus for Heating Building, and Gas Holder Tanks. Lamp Posts and Lanterns.

P. Munzinger's Patent Ash Lime Trays.



In use at the following Gas-Light Companies:

Pittsburg Gas Company, Pa.
Peoples Gas Company, Baltimore.
Lowell Gas-Light Company, Mass.
Lynn Gas-Light Company, Mass.
Albany Gas-Light Company, N. Y.
Schenectady Gas-Light Company, N. Y.
Utica Gas-Light Company, N. Y.
Jersey City Gas Company, N. J.
St. Paul Gas-Light Company, Minn.
Cumberland Gas-Light Company, Md.
Hartford City Gas-Light Company, Conn.
Richmond Gas Company, Va.
McKeesport Gas Company, Pa.
Middletown Gas Company, Pa.
East Newark Gas-Light Company, N. J.
Binghampton Gas Company, N. J.
Zanesville Gas Company, Ohio.

New Orleans Gas Company, La.
Salem Gas-Light Company, Mass.
New Britain Gas-Light Company, Conn.
Rahway Gas-Light Company, N. J.
Trenton Gas-Light Company, N. J.
Elmira Gas Company, New York.
Erie Gas Company, Pa.
Columbus Gas-Light Company, Ohio.
Westchester Gas-Light Company, N. Y.
Santa Cruz Gas Company, Cal.
Lawrence Gas-Light Company, Kansas.
Salem Gas Company, N. J.
Indiana Gas-Light Company, Pa.
Peoria Gas Company, Ill.
Montclair Gas Company, N. J.
Williamsport Gas Company, Pa.
Wooster Gas-Light Company, Ohio.

Augusta Gas-Light Company, Ga.
Huntsville Gas Company, Ga.
Chattanooga Gas Company Tenn.
Murfreesboro Gas Company, Tenn.
Hagerstown Gas-Light Company, Md.
Hanover Gas Company, Pa.
Easton Gas Company, Pa.
Uniontown Gas-Light Company, Pa.
Coatesville Gas-Light Company, Pa.
Houston, Gas Company, Texas.
Wilkesbarre Gas Company, La.
Middletown Gas Company, New York.
Washington Gas-Light Company, Pa.
Princeton Gas-Light Company, N. J.
Newark Gas Company, Ohio.
Pontiac Gas-Light Company, Mich.
And numerous other Companies.